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The morphology of Taenioma

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(WITH PLATES 9 AND 10)

The work here described was done in the Botanical Laboratory of Barnard College, Columbia University, under the direction of Professor H. M. Richards, for whose kindly interest and assistance, as well as that of Dr. T. E. Hazen, I wish to express my deep appreciation. I am greatly indebted also to Dr. M. A. Howe of the New York Botanical Garden, through whose kindness the material has been available for this work. The material used was collected by Dr. Howe on two of his southern trips and was preserved with the aid of formaldehyde as well as by drying. The fertile plants, possessing all the kinds of reproductive organs, were obtained in Porto Rico in 1903; sterile (rarely tetrasporic) plants were collected in the Bahamas (West Caicos) in 1907.

It is not the purpose here to determine the species to which these two plants belong. There are minor differences between them. The plant from Porto Rico (antheridial, cystocarpic, and tetrasporic) appears larger, is dark violet in color, less secundly branched, and the short flattened shoots are longer, sometimes 15–30 segments in length, are more closely and more conspicuously fasciculate or even fastigiate, and are prolonged into three hairs; while the plant from the Bahamas (sterile or rarely tetrasporic) is smaller, reddish purple in color, the branches are apparently more secund and the short flattened shoots, 9–15 segments in length, are prolonged into two hairs. In spite of these differences there seems little reason to doubt that both of these plants belong to the spe-

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cies *Taenioma macrourum* (Schousb.) Thuret.* According to Falkenberg ('01) the *Taenioma macrourum* which he found near Naples had short shoots ending in two hairs and but 15–20 segments long, which is somewhat longer than the specimen from the Bahamas; otherwise the two agree. The Bahamian plant also agrees with the *Taenioma macrourum*, as described originally by Thuret ('76) from plants collected by Schousboe in Tangier, as far as can be determined by the figures given and by the somewhat condensed description. Agardh ('63) alone notes that the flattened shoots are often prolonged into three hairs, but he is writing of *Taenioma per-*

* [EDITORIAL NOTE.—From a study of Thuret's description and figures of his *Taenioma macrourum*, based on Schousboe's plant from Tangier, Morocco (*Polysiphonia macroura* Schousb. in herb.), Miss Thompson seems to be justified in identifying at least the Bahamian plant with this species. But the question still remains as to the identity of this *T. macrourum* with the previously described *Taenioma perpusillum* of J. Agardh, based on material collected on the Pacific coast of Mexico. Thuret had not seen Agardh's specimen, but in proposing Schousboe's as a different species, he was influenced by the widely separated stations of the two plants, by some apparent differences in size and color, judging from Agardh's description, and by Agardh's alleged silence as to the apical division of the stichidium and the elongation of its divisions into two hyaline hairs. Agardh, however, does state that the stichidia are often excurrent at the apex "in fila minuta 3." I have had the opportunity of comparing Agardh's original specimen of *Taenioma perpusillum* (*Polysiphonia perpusilla* J. Ag. Öfv. Kongl. Vet.-Akad. Förh. **4**: 16. 1847), in the Agardh herbarium at Lund, with my specimen from Porto Rico (Aguadilla, June 15, 1902, *no. 2433*) and find them essentially the same except that the terminal hairs are much longer and more luxuriant in the Porto Rican plant. In the original *T. perpusillum* the stichidia often terminate in three short hairs, as described by Agardh. My Bahamian specimens (West Caicos, December 20, 1907, *no. 5708*) differ in several respects from the Porto Rican, as indicated above by Miss Thompson. However, they are mostly sterile and they were found growing in an inland pond or lake, having, evidently, a subterranean communication with the sea — a place where several marine algae of recognizable species were more or less abnormal and peculiar. The color of these specimens when dry is reddish purple instead of the sordid green attributed to *T. macrourum* by Thuret and the terminal hairs (always, apparently, in twos) are commonly shorter than in the figures published by Bornet & Thuret and by Falkenberg, though often longer than any figured by Miss Thompson. In the Porto Rican specimens, the terminal hairs, which are nearly always in threes, though rarely in twos, are fully as long and as well developed as those figured by Bornet & Thuret and by Falkenberg for *T. macrourum*, though one, perhaps, might not infer this to be the fact from the figures drawn by Miss Thompson. The Porto Rican plants, by the way, were growing where they were well exposed to the surge of the open sea. From the evidence thus far available I am inclined to agree with Bornet (Mem. Soc. Nat. Sci. Cherbourg **28**: 297. 1892), with Heydrich (Hedwigia **33**: 295. 1894), and with De-Toni (Sylloge Algarum **4**: 732. 1900) in considering *Taenioma macrourum* (Schousb.) Thuret a synonym of *Taenioma perpusillum* J. Ag. — M. A. H.]

pusillum J. Ag. and not of *T. macrourum* (Schousb.) Thuret. However, although it would seem probable that both of my specimens should be classed with *T. macrourum*, a discussion of the classification would not be profitable here, since this work concerns itself not with a determination of species, but with a description of the exact method of growth and cell division, and the appearance and formation of the reproductive organs.

The species of *Taenioma* studied is a small marine alga, forming dense tufts on other algae, or on sticks of wood near the low-water line. It is purplish red or dark violet in color, and minute in size as to the individual plants, though forming, in mass, patches easily distinguishable. The main axis is monopodial, siphonous, branched, creeping, segmented, and not corticated, and is attached to the substratum by numerous rhizoids (FIG. 1). Branches arising from the main stem are in turn much branched, frequently forming long secondary axes, which are prostrate and produce rhizoids. The shorter secondary axes are erect, arising alternately from either side of the stem, those on the lower side twisting in the process of erection, so that superficially they appear secund. Both these and the main shoot bear short flattened shoots, arising alternately, and prolonged at the apex into two or three long monosiphonous hairs. Growth takes place by means of a single apical cell which is recorded by Agardh ('63) as dividing dichotomously. Since the cell does not divide by a longitudinal split, as will be shown later, and since the main axis is monopodial, this cannot be considered true dichotomy, although the branching may be called subdichotomous.

The rhizoids are numerous, arising irregularly, each being a direct prolongation of any pericentral cell on the under side of the thallus. They are unicellular, often of considerable length, with ends rounded or spread out into disks or forked projections (FIG. 2).

The main stem or primary monopodial axis of the plant is composed of four pericentral siphons in protoplasmic connection with each other and with the central siphon. This latter forms a distinct core through the stem, the cells being elongated and closely joined, with deep pit connections. A stem segment is cylindrical, composed of four of these pericentral cells with the corresponding axial cell. No evidence of cortication has been

observed at the joints, even in the oldest portions. The method of growth is by a single dome-shaped apical cell, which cuts off disk-shaped cells at its base, each of which will correspond to a single segment in the fully formed stem. When the formation of a branch is to take place, the apical cell divides by an oblique wall into two unequal parts. The smaller of the two is the cell which will continue the main axis; the larger increases laterally and divides by an oblique wall at right angles to the first. This second dome-shaped apical cell forms the apical cell of a secondary axis (FIG. 4). Hence it is evident that this branching is not true dichotomy, since the two newly formed apical cells are not the product of the single division of an apical cell. The cell of the shoot tip is the true apical cell, for the branch apical cell is formed secondarily by the further growth and division in a cell underlying the tip cell. The apical cell of the tip next cuts off 3–6 disk-shaped segments below, in which soon appear two longitudinal divisions, separating these segments into three cells in a row in one plane.* Somewhat later and usually just behind the first branch formed from the tip, two other longitudinal divisions, parallel to each other and perpendicular to the first division, occur in the middle cell, forming the other two pericentral cells. Consequently in the fully formed stem the branches are separated by three to six segments, whose structure superficially resembles that of a simple *Polysiphonia* (FIG. 3).

The secondary axes develop in the same way as the main shoot, from the apical cell mentioned above. They may be short and erect with but 2–6 branches (FIG. 1), or they may be long and recumbent, giving rise to similar tertiary axes. On them as lateral outgrowths appear the flat short branches, and also the reproductive organs, the stichidia with tetraspores, the antheridia, and the cystocarps.

The flat shoots (FIG. 11) arise in the following manner: An apical cell of the axis divides into a growing tip cell and a branch cell as before (FIG. 4). This branch apical cell cuts off below disk-shaped segments until a filament of 9–30 cells is formed (FIG. 7). It then divides as did the apical cell into two, from

* Longitudinal will be used throughout as indicating a division parallel to the axis; transverse as across the plant.

which come the long narrow monosiphonous hairs (1–many cells in length) at the apex (FIGS. 6, 7, 8). In the case of the plant having three hairs, the formation of the third hair presents no variation. After the second apical cell has been separated off, the larger lower cell again increases laterally and a third cell is formed by division. After the hairs begin their formation no further transverse split takes place in the branch cells already formed, thus fixing definitely at this point the number of segments in a mature branch. The first divisions of the branch cells are similar to those of the stem. Two longitudinal divisions split the filament into a plate of cells in three rows (FIG. 10). But now a characteristic change takes place in the two outer rows. In these cells an oblique wall, first occurring in the upper half, splits off a triangular cell one third the size of the original, then a second of like shape and size in the lower half, forming three cells: an inner pericentral cell of the same height but one half the width, and two outer marginal cells, one lying above the other, one half as long and one half as wide as the original cell (FIG. 9). Simultaneously with these divisions two longitudinal ones in the central row of cells divide it into a midrib, three cells in thickness. These divisions all begin at the base of the branch and proceed to the apex. A flat-branch segment in distinction from an axis segment now consists of nine cells; three in the midrib, a pericentral cell on each side of the midrib, and beyond each of these two small marginal cells. These segments are of a similar structure throughout the branch with the exception of 2–4 at the base, which do not form the small marginal cells, but have four pericentral siphons like those of the main axis.

Up to the present time, so far as my knowledge goes, the tetraspores have been the only known organs of reproduction of *Taenioma*. These have been mentioned both by Bornet and Thuret, and by Agardh. Bornet and Thuret ('76) merely figure and describe very briefly the gross appearance and position of the stichidia with no account of the tetrasporic formation. Agardh ('63) gives a fuller account, but yet does not satisfactorily present in detail all cell divisions taking place in the stichidia. This account will supplement both the above, as well as the later description and figures given by Falkenberg. In the material examined,

both the Porto Rican plant with the three-haired branches, and the Bahamian one with the two-haired branches produced tetrasporic stichidia. Agardh ('63) speaks of the stichidia as "often excurrent at the top into three minute hairs, of which the middle one continues the middle part of the segment [*i. e.*, the midrib] the marginal ones the marginal cells" [translation]. This corresponds exactly to my Porto Rican material. There the tetrasporangia are formed in stichidia on the flat shoots of the secondary axes in considerable number (FIG. 12). These stichidia are flat branches which remain practically unmodified except that, with the formation of the large tetraspores, they become somewhat broader. The tetrasporangia are formed in two long rows from the two pericentral cells which lie one on each side of the midrib. A transverse division first separates these cells into an upper and a lower half (FIG. 13). The upper half becomes the mother-cell of the tetraspores. The lower half divides by two longitudinal divisions parallel to the flat surface of the branch into a layer of three cells in thickness. These become crowded and elongated in a radial direction by the growth of the tetraspore mother-cells. The upper half of the pericentral cell enlarges greatly to form the tetraspore mother-cell, which still remains in protoplasmic communication with the lower layer of supporting cells. To form the tetraspores, the contents of the mother-cell divide first into two by a longitudinal wall parallel to the flat surface of the stichidium (FIG. 14). A transverse division forms two tetraspores from one half, and another division, at right angles to the planes of the first two divisions, correspondingly forms the two in the second half. These are therefore one form of "cruciate" tetraspores. They are held within the mother-cell wall, which breaks when mature, allowing the tetraspores to escape. These lateral pericentral cells are the only ones to be modified, the midrib and the marginal cells being unchanged. The entire branch or only a portion of it may be transformed into a stichidium.

Little has been known heretofore concerning the antheridia. Falkenberg ('01) figures a shoot bearing two large conical protuberances, seemingly filled with, or composed of, small cells, but he rightly concludes that these are malformations and not antheridia. De-Toni ('00) mentions antheridia as spots between the

middle vein and the margins of the branches, a description which does not wholly correspond to the antheridia as seen in the material at hand. In this, antheridia are formed, as are the tetrasporangia, in ordinary flattened branches, clustered near the growing tips of the secondary axes (FIG. 15). The entire branch (with the exceptions noted below) is usually transformed into antheridial cells, although these may be found only in the middle portion, while the cells at base and apex of the branch remain unchanged. In the formation of the antheridia the first divisions occur in the row of marginal cells. A longitudinal split cuts each into two (FIG. 17). After the first division of the marginal cells into two, the outer row of these never divides again, so that, in the mature antheridium, there is always to be seen a row of marginal cells one half the size of the original ones (FIG. 18). The inner row divides irregularly into many small cells. The lateral pericentral cells now become modified, being cut by both longitudinal and transverse divisions into numerous small cubical cells (FIG. 16). Before these are entirely completed, a longitudinal split parallel to the flat surface of the shoot takes place. This causes the shoot to become a flattened plate of small angular cells, two layers of cells in thickness, with two exceptions: (1) the midrib, which remains entirely unchanged, and (2) the marginal cells. Next, the true antheridial cells are separated from these mother-cells in the two layers on the side toward the surface of the flat shoot (FIG. 19). These very small, ovoid bodies, containing the spermatia, are all in protoplasmic connection and are formed 2–4 to a mother-cell, 4 being probably the normal number. At regular intervals in the antheridial branch there can be noticed a faint line of separation from the midrib to the margin, denoting the original separation of cells into segments (FIG. 15).

Although the tetraspores have been known since the plant was first described, and the presence of antheridia has more recently been alluded to, the cystocarp has been absolutely unknown. De-Toni ('00) says specifically "Cystocarpia ignota" and other literature on the subject does not mention them at all. It has been my good fortune to find in the material collected at Porto Rico a number of cystocarpic specimens. Unfortunately the material has not afforded sufficient stages to trace the growth of the cystocarp from its beginning, nor has there been a sufficient number of

mature cystocarps to make sectioning by microtome possible. The young material was not satisfactory. No procarps were distinguishable as such, although in several instances there appeared to be distortions of normal cells, forming slight protuberances, looking like small malformed branches in some cases. Here indications were found of a row of three small cells which led me to consider the possibility of these being unfertilized and disorganized procarps. In no case was a trichogyne found. The young stages of the cystocarp, when crushed, lost all cell connections, so that no details of their interior structure could be seen. The mature cystocarp from its position is a modified branch, and is situated directly on an axis, not on a flattened branch (FIG. 20). It is a prominent flask-shaped, sessile body, resembling that of *Dasya*, with a large rounded base containing the carpospores, and a long narrow neck which opens at the tip by a distinct carpostome. (The cystocarp pictured is not fully mature, hence the neck is shorter than normal.) The outer covering of cells appears to be continuous with the pericentral cells, and thus probably developed from them. The wall cells are irregularly angular and one layer in thickness. By crushing the material and noting the position of parts, the cystocarp appears to correspond in many details with those of the Rhodomelaceae, especially with those of *Dasya* and *Chondria*, as described by Phillips ('96). The paranematal filaments which he mentions in all these forms are here very apparent; they consist of about 12 chains of cells springing from the base of the cystocarp; but their origin could not be distinguished. These filaments extend to the carpostome. They are narrow and distinct, and do not form in any sense an inner lining to the cystocarp. Also, on crushing, the following structures appeared to constitute the inner apparatus of one cystocarp, which structures were later confirmed by those from a second (FIG. 21). In both cases a comparatively large central cell bore at its apex, by deep pit connections, four large rounded cells. From these proceeded long branching filaments, the sporogenous filaments, on whose tips were borne the large ellipsoidal carpospores. At the base of this central cell was attached a single cell, in the first case examined, and three cells in the second case. Since the central cell was larger in the first, it might be suggested that the cystocarp was older and that a process of absorption of the surrounding cells by the central cell (an auxiliary cell?) was

taking place during the formation of the carpospores. In the second case, not pictured here, one of the lower lateral cells is producing a mass of branching filaments. In two other cystocarps, before crushing, a cluster of filaments was observed at the base of the true spore clusters. This cluster was formed of small elongated cells, densely branching, and apparently without carpospores. Although their connection with the main cells could not be discovered, the question suggested itself: might these not be the two branches of sterile cells found by Phillips ('95, '96) in all the Rhodomelaceae? From this necessarily incomplete account, which merely suggests the identity of the structures observed, it can be seen that much more investigation remains to be done on the cystocarp.

According to the classification of Schmitz & Hauptfleisch ('97), *Taenioma* is placed in the family Delesseriaceae. This position is determined from the similarity of the thallus to those of some members of that family, such as the well-known *Caloglossa*, and also from the formation of the tetraspores in two rows along a midrib. This would seem logical when the tetrasporic reproduction was the only method known. However, with the discovery of the cystocarps, and their strong resemblance to those of *Dasya* and *Chondria*, as described by Phillips ('96), it would seem as if *Taenioma* had been wrongly placed, and that it belongs in the family Rhodomelaceae. The structure of the thallus and the method of branching, resemble that of the simpler members of the Rhodomelaceae and the formation and position of the tetraspores are not such as to exclude it from this latter family. Indeed, from Hauck's ('85) description of the placentation of the cystocarp it must belong here. According to his descriptions the distinguishing mark of the Delesseriaceae is the broad basal placental cell of the cystocarp, from which the sporogenous filaments come in clusters. In distinction to this the placentation in the cystocarps of the Rhodomelaceae is an upright central cell bearing the branching sporogenous filaments at its apex. On comparison with FIG. 21, the latter method of placentation is clearly recognized to obtain in *Taenioma*, which undoubtedly would cause this alga to be placed in the family Rhodomelaceae.

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Explanation of plates 9 and 10

Slides were prepared by staining with eosin and fixing with acetic acid, and by further treatment with potash and lactic acid.

Drawings were made with an Abbé camera lucida, and are reduced one half.

Figures 1–11 were drawn from the Bahamian material; figures 12–21, from the Porto Rican.

1. Portion of the prostrate main axis (×45).
2. Segment of the axis with rhizoids (×107).
3. Growing apex, showing alternation of branches (×107).

4–11. Development of flat shoot (×278).

4. Division of apical cell.
5. Main axis with young branch.
6. Division of apical cell to form hairs.
7. Branch showing filament of cells.

8, 10. First longitudinal divisions of shoot.

9. Divisions forming marginal cells.
11. Fully formed shoot.
12. Branch bearing stichidia (×45).
13. Portion of stichidium, showing division of pericentral cells to form tetrasporangium (×278).
14. Mature stichidium with fully formed tetraspores (×278).
15. Branch with antheridia (×45).

16–19. Development of antheridia.

16. Divisions in pericentral cells (×278).
17. First division of marginal cells (×107).
18. Portion of discharged antheridium (×360).
19. Antheridial cells with mother cells (×360).
20. Branch with cystocarp (×45).
21. Interior cells of cystocarp (×278).

A botanical and geological trip on the Warrior and Tombigbee rivers in the coastal plain of Alabama

ROLAND M. HARPER

Since Nuttall's memorable journey of exploration on the Ohio, Mississippi, and Arkansas Rivers in the years 1818 to 1820,* probably very few botanists have traveled any considerable distance by daylight on any of the navigable rivers of our coastal plain. At the present time passenger traffic has almost ceased on many rivers which were once important arteries of commerce, partly on account of railroad competition and partly on account of great variations in the volume of water, due presumably to deforestation of drainage areas; and even where there are still regular lines of steamboats it is not easy to plan a satisfactory trip on one of them. For the boat schedules are in many cases irregular, infrequent, or not widely advertised, and the connections with railroads too often inconvenient or uncertain; and above all, when a river journey extends over 100 miles or so a part of it is usually made at night and a good deal of scenery thus missed.

On account of these conditions, previous to the fall of 1908 I had traveled on a river boat but once (and that was for a distance of only about twenty miles, on the Tennessee River in the Paleozoic region of Alabama); but in October of the year named a rare opportunity was presented for a much more extensive river trip, all by daylight, and at the same time with ample facilities for botanizing. An expedition was being organized by Dr. Eugene A. Smith, state geologist of Alabama, for the purpose of clearing up a few doubtful points in stratigraphy by examining the exceptionally complete geological sections displayed in the river-bluffs between Tuscaloosa and Mobile; and the writer was invited to participate. The other members of the party were seven well-known geologists besides Dr. Smith (most of them connected with state geological

* See his "Journal of travels into the Arkansa territory," published in 1821, and reprinted in 1905 as vol. 13 of Thwaites's "Early western travels."

surveys in the southeastern states), a young minister (who was also a conchologist), a navigator, and a negro cook.

The trip was made in an old house-boat refitted for the occasion, towed by a 20-horse-power gasolene launch. Our best speed (including the acceleration of the current of something like a mile an hour) was about six miles an hour; and the distance covered between sunrise and nightfall each day averaged about twenty-six miles, but varied greatly with the number of bluffs to be examined and the difficulties encountered, from one to forty-nine miles.

Our voyage began on the morning of October 7, 1908, at the fall-line on the Warrior River, in the city of Tuscaloosa, and ended on the evening of the 16th at Jackson, near the head of tide-water on the Tombigbee, 261 miles from Tuscaloosa and 100 from Mobile, by the river. Although there would doubtless have been much of botanical interest below Jackson,* the geologists did not care to go any farther than that, for there are said to be no important bluffs on the tidal part of this river. The river at this time was almost at its lowest stage, because its headwaters are mostly in regions which have their greatest rainfall in winter and spring and least in summer and fall, as seems to be the case in most of the country between the mountains and the coastal plain in the southeastern states.† This state of affairs greatly facilitated our examination of the banks, but at the same time it caused most vexatious delays at the shallowest places, which were usually just below the mouths of swift creeks, which bring down coarse sand and gravel faster than the slower current of the river can remove it, and thus form shoals.

But on the whole probably no better season of the year could

* A description of some of the swamps between Jackson and Mobile can be found in Bartram's Travels, part 3, chapter 6; and parts of the same have been described in some of Dr. Mohr's writings. For the region now under consideration there is hardly any previous botanical literature to be cited. Excellent geological descriptions, with cuts of some of the bluffs, by Dr. Smith and others, have been published in Bulletin 43 of the U. S. Geological Survey, 1887, and in the "Report on the geology of the coastal plain of Alabama," issued by the state survey in 1894.

† The surface of the Warrior River at Tuscaloosa is about 90 feet above sea-level at low water, usually in October, and 150 feet at high water, usually in March. (Farther down stream the elevations are of course proportionately lower.) The smallest flow ever recorded there was 90 cubic feet a second, on October, 15, 1897, and the largest 136,687 cubic feet, on April 18, 1900; an enormous variation. The average is about 8,000, which is nearly two cubic feet a second for every square mile drained.

have been selected, for we enjoyed ideal weather most of the time, and entire freedom from mosquitoes; and although not many plants along the river were in bloom, there were few if any which were not in the right condition for identification.

One of the indirect effects of civilization in Alabama is that locks and dams now have to be provided in the larger rivers to make navigation possible at all seasons.* There are to be nine locks between Tuscaloosa and Jackson when the contemplated river "improvements" are completed, but at the time of our trip the second and third (counting from tide-water) were unfinished, and all our difficulties were in the part of the Tombigbee to be served by them, a distance of not quite fifty miles. This system of locks, while it seems to be an economic necessity, is a detriment to science in more ways than one. In the first place, it seriously interrupts the normal life-history or physiographic development of the rivers, and, what was of more concern to our party, it has permanently covered the lowest few feet of one of the most important bluffs with an opaque screen of muddy water.†

The Warrior River has its sources among the Carboniferous plateaus of northern Alabama, leaves the highlands at Tuscaloosa, and at Demopolis, 130 miles farther down, joins the Tombigbee, which derives most of its water above that point from the Cretaceous region of western Alabama and northeastern Mississippi. The Warrior between Tuscaloosa and Demopolis probably averages a little less than 100 yards in width, and the Tombigbee between Demopolis and Jackson a little more. In most of what follows the two rivers will be treated as one, the fact that the name of the lower portion continues up the western instead of the eastern branch at Demopolis being more or less arbitrary or accidental. After passing through Tuscaloosa County this river forms a county boundary the rest of the way to the Gulf,‡ passing the

* Locks for navigation are practically unknown in the other southeastern states, probably because those states have much less heavy freight, such as coal and cement, to export than Alabama has, and also partly because most of the navigable rivers in the other states could not be dammed up much without flooding large areas.

† The only known station in Alabama for *Hymenocallis coronaria* (see Mohr, Contr. U. S. Nat. Herb. **6**: 447. 1901) has probably been destroyed by this time, by the same process.

‡ It is probably largely for this reason that there are no wagon bridges across it below Tuscaloosa County.

following counties alternately on the right and left: Greene, Hale, Sumter, Marengo, Choctaw, Clarke, and Washington (besides Baldwin and Mobile below the point where our journey ended).

Like most rivers of gentle slope, this one meanders so that distances by water are about twice as great as by air line, and forms bluffs on the convex sides of the bends in the usual manner. The bends are naturally shorter and sharper on the Warrior than on the Tombigbee, on account of the smaller volume of water; and for some reason not altogether obvious, they seem to be most frequent in the region of the Eutaw formation, in the upper parts of Hale and Greene counties.

The banks of the river present a variety of aspects, according to the material of which they are composed, and their position with respect to the meanders and to the sun. Lithologically they are sandstone, limestone, clay, sand, mud, or various intermediate conditions; and there is often considerable variation in a single formation. The oldest material is the stratified Cretaceous and Eocene rocks, which in some places extend as much as 200 feet above the water, in steep bluffs, and elsewhere are entirely under water, or concealed by later formations. Capping the stratified rocks on bluffs which extend above high-water mark can often be seen the stiff reddish loam of the Lafayette formation, which is probably Pliocene. Bluffs not more than 30 feet high are often composed entirely of "second bottom" deposits (Pleistocene), which are usually of loose buff-colored loam, and level on top for considerable distances. Recent alluvium is confined chiefly to low banks subject to frequent inundation. These are of comparatively limited extent, however, and there is very little swamp along any of the rivers in the Cretaceous and Eocene regions of Alabama.

The alluvial banks often slide into the river, carrying down whatever trees grow on them (mostly willows in such places) and drowning them. This phenomenon is especially common in the region of the Tuscaloosa formation (which consists mostly of slippery clay, and lines the river-banks for the first 60 miles below Tuscaloosa), where rows of dead willows are in sight from nearly every point. In this same portion of the river, and apparently nowhere else on our route, are many cut-offs or ox-bow lakes, showing that the channel has been shifting there rather fre-

quently. The bars of sand and gravel which give rise to shoals have been mentioned above.

In Choctaw, Clarke, and Washington counties on the last two days of the trip we got frequent glimpses of the "mountains," which are a characteristic feature of this part of Alabama * and adjacent Mississippi, but are almost unknown to botanists and geographers. These are high rocky ridges, mostly of the buhrstone (Middle Eocene) formation, extending in a general north-

FIGURE 1. Mt. Ararat (near the center) and McCarthy's Bluff, Choctaw County, Alabama, looking downstream from the boat, October 15, 1908.

west-southeast direction. In a few places where the river impinges directly against them they form bluffs over 200 feet high, which is "doing pretty well" for the coastal plain. A distant view of one of them is subjoined. A few plants which grow on them are mentioned in the geological reports cited, and some others will be discussed in the latter part of this paper.

Four divisions of the Cretaceous strata are represented in western Alabama, namely, the Tuscaloosa, Eutaw, Selma Chalk or Rotten Limestone, and Ripley. These are quite easily recognized along the river by their different appearance or lithological

*See Smith, Tenth Census U. S. 6: 55 (line 11), 143–145 [bottom pagination]. 1884; U. S. Geol. Surv. Bull. 43: 35–42. 1887; Geol. of Coastal Plain of Ala. 620–622, 630, 633, 634, 640–641, 645–647. 1894; Mohr, Contr. U. S. Nat. Herb. 6: 107. 1901.

composition, and in the country away from the river by their characteristic topography and vegetation. The Eocene, which begins at Moscow Bluff on the Tombigbee, about 15 miles below Demopolis and just above the upper mouth of Sucarnochee Creek in Sumter County, has numerous subdivisions, which are not so easily recognized by one who is not a paleontologist, and therefore scarcely need to be mentioned here. Details concerning them can be found in the geological reports cited above.

Except for the locks already mentioned, civilization has not done much damage along the banks of these rivers. The highest bluffs are not cultivated because of their difficulty of access, and the lowest banks because of their liability to inundation, so that such places are generally pretty well wooded. The cultivated fields visible from a boat are mostly in the "second bottoms," just above the reach of floods. And such locations are not considered very healthy to live in, consequently not many houses are to be seen. Cotton warehouses, with inclined tracks leading down to the water, are frequent on the bluffs of the lower Tombigbee, but rare or absent on the Warrior, probably largely because there navigation has hitherto been almost impossible in the fall, which is the cotton season. Lumbering has apparently not been carried on much in the region we traversed, probably because the prevailing trees near the river are hardwoods and short-leaf pines, for which there is not much demand. Long-leaf pine, the most important tree in Alabama, seldom grows on river-banks, but after we came within its range (which was not until the second week) we passed several wood landings and even a few logging railroads, by means of which the trunks of this noble tree were being hauled down from the uplands and embarked on their voyage to the seaport sawmills. Cypress, the most important river-bank tree of the coastal plain, probably never was very abundant along our route, for the banks are in most places too steep for it.

Having sketched the main geographical features of the river, we are now ready to consider in some detail the vegetation along its banks. While the boat was moving I wrote down the names of all the species I could identity, starting anew after every recognizable landing, bluff, creek, etc. As we usually kept near the middle of the river, and no one had thought to bring along a field-

glass, my notes made on the boat were chiefly confined to trees, shrubs, and vines. But our frequent stops at the bluffs, lasting from half an hour to several hours or all night, gave me opportunity to note many herbs and check up my identifications of the woody plants, and to do a little collecting. A few short trips away from the river on foot were also made, the longest being from Beckley's Landing in Marengo County via Myrtlewood to Naheola ferry, a walk of eight or ten miles (with one companion), which cut off about fifteen miles of river. The plants noted on such trips are not counted with those on the river-banks, however.

One extreme method of treating the plants observed would be to combine them all in a single list, and the other would be to consider each geological formation separately and classify the plants growing on or near it according to habitat, as far as possible. But the former method would obscure some interesting features of distribution, and my notes are not complete enough to make it worth while to attempt the latter. Another method would be to consider the Warrior and Tombigbee Rivers separately, thus dividing the journey into two equal parts. But this would be rather arbitrary, for the upper Tombigbee does not flow through any kind of country that the Warrior does not, so that there was no perceptible change of natural conditions as we passed Demopolis except an increased flow of water. (If we had started at the head of navigation on the Tombigbee instead of on the Warrior, then Demopolis might have been a logical dividing point, for the Warrior doubtless brings down from the mountains seeds of quite a number of plants which do not grow along the upper Tombigbee at all.)

The dividing line between the Cretaceous and Eocene formations is a line which several species growing along the river do not seem to cross, and by dividing the notes there some interesting features of distribution can be brought out. That method is here adopted.

In the following table the plants of the Cretaceous and Eocene portions of the river banks are listed in parallel columns. They are divided first into trees, shrubs, and herbs, then arranged in order of apparent frequency, the number prefixed to each being the number of times it was noted in the region under which it is

listed. Those seen only once or twice are omitted from this table. The names of vines are italicized, evergreens are in small CAPITALS,* parasites in parentheses, and epiphytes in brackets.† Author-citations are not considered necessary here, and times of flowering, modes of dissemination, etc., are not accurately known in most cases, and are therefore omitted. All the plants visible from the river naturally do not have the same habitat, but it is hardly worth while at this time to go into details of zonation, etc. I have however added the symbol (H) to the names of those species which were seen only on high bluffs or in hammocks or second bottoms, above ordinary high water. Species which grow sometimes above and sometimes below this level are indicated by (h).

CRETACEOUS

TREES

99 Salix nigra
91 Platanus occidentalis
78 Betula nigra
75 Acer saccharinum
68 Planera aquatica
65 Populus deltoides
61 Taxodium distichum
50 PINUS TAEDA (H)
30 Hicoria aquatica
30 Liquidambar Styraciflua (h)
19 Quercus lyrata
9 Fagus grandifolia (H)
8 QUERCUS LAURIFOLIA (H)
6 Morus rubra
5 JUNIPERUS VIRGINIANA (H)
5 PINUS ECHINATA (H)
4 QUERCUS NIGRA (h)
3 Carpinus caroliniana (h)

EOCENE

TREES

82 Salix nigra
77 Populus deltoides
47 Platanus occidentalis
38 Acer saccharinum
24 Planera aquatica
23 Taxodium distichum
22 Betula nigra
14 PINUS TAEDA (H)
11 PINUS GLABRA (H)
9 Liquidambar Styraciflua (h)
7 MAGNOLIA GRANDIFLORA
7 Fraxinus americana ?
5 Fagus grandifolia (H)
3 Morus rubra (h)
3 Hicoria aquatica
3 Cercis canadensis (H)
3 ILEX OPACA (H)

* [The author preferred to use bold-face type for the evergreens, but for the past eleven years the BULLETIN has reserved that style of type for new names and new combinations of names. — ED.]

† For a more detailed explanation of this method of treating plant lists, see Ann. N. Y. Acad. Sci. 17: 36–39. 1906.

CRETACEOUS

SHRUBS

73 *Brunnichia cirrhosa*
50 (PHORADENDRON FLAVESCENS)
45 ARUNDINARIA MACROSPERMA
16 Alnus rugosa (h)
15 *Tecoma radicans*
7 *Rhus radicans*
5 *Vitis vulpina*
4 Amorpha fruticosa
4 *Ampelopsis arborea*
3 *Bignonia* CRUCIGERA (h)
3 *Ampelopsis cordata*
3 Adelia acuminata

HERBS

36 Onoclea sensibilis
36 *Sicyos angulatus*
20 Aster lateriflorus
18 [TILLANDSIA USNEOIDES]
12 Conoclinium coelestinum
11 Fimbristylis Vahlii
9 Uniola latifolia
7 Osmunda regalis
4 Dianthera americana
4 Panicum virgatum (h)
3 Xanthium sp.
3 [POLYPODIUM POLYPODIOIDES]
3 ADIANTUM CAPILLUS-VENERIS

EOCENE

SHRUBS

44 (PHORADENDRON FLAVESCENS)
25 *Brunnichia cirrhosa*
15 ARUNDINARIA MACROSPERMA
12 Adelia acuminata
12 *Tecoma radicans*
9 *Vitis vulpina*
5 *Ampelopsis arborea*
4 Amorpha fruticosa
4 *Rhus radicans*
3 Cephalanthus occidentalis

HERBS

48 [TILLANDSIA USNEOIDES]
42 *Sicyos angulatus*
14 Dianthera americana
14 Xanthium sp.
9 Onoclea sensibilis
7 *Ipomoea lacunosa*
6 Spermacoce glabra
6 Acuan illinoense
5 Amaranthus sp.
5 Paspalum mucronatum
5 Sesbania macrocarpa
5 Ammannia coccinea
4 Fimbristylis Vahlii
4 Eclipta alba
4 Panicum virgatum (h)
4 Andropogon furcatus (H)
4 Cardiospermum Halicacabum
3 Commelina hirtella
3 Acalypha virginica
3 Euphorbia nutans
3 Echinochloa Crus-galli
3 Leptochloa mucronata
3 Euphorbia humistrata?
3 *Gonolobus laevis?**
3 Sida spinosa

Gonolobus laevis* Michx. (*Enslenia albida* Nutt. See Vail, Bull. Torrey Club **26: 427, 428. 1899.) The plants I examined differ from current descriptions in having no milky juice, and follicles neither angled nor erect; but most descriptions seem to be silent on these points, perhaps not without reason. I preserved no specimens.

The higher numbers for the shrubs and trees in the first column are of course due principally to the fact that we traveled 145 miles through the Cretaceous and only 116 through the Eocene. The slightly greater number of woody plants in the Cretaceous list may be due to the same cause, and the excess of herbs in the second column to the fact that we landed oftener in the Eocene region; but there is also a possibility that this may be a part of the general tendency for woody plants to be most numerous in climax forests and herbs in pioneer forests—the Cretaceous region having of course been above the sea longer than the Eocene.

A few words on habitats should be inserted here. The favorite habitat of the *Alnus*, *Aster*, *Onoclea*, *Osmunda*, and *Adiantum* was at the line of contact between the Cretaceous and second-bottom deposits, where water is perpetually seeping out, on shaded bluffs of moderate height. In such places the four herbs just mentioned usually hang down against vertical cliffs, which in the case of the *Onoclea* and *Osmunda* at least is somewhat of a departure from their habit elsewhere. The *Dianthera*, *Ammannia* and several Cyperaceae not seen often enough to be mentioned in the above table commonly grow on gently sloping clayey Eocene strata near the bases of bluffs, where they are usually moistened by trickling water from above when the river is low and completely submerged when it is high. The *Phoradendron* seemed to grow oftener on *Populus* than on any other tree. It was also frequent on *Acer*, less so on *Betula*, occasional on *Platanus*, but apparently never on *Salix*, *Planera*, or any of the conifers.

If the hammock and high bluff plants, which happen to be mostly trees, be disregarded, the most striking features of both lists are the scarcity of evergreens and the large proportion of vines. This seems to be characteristic of most alluvial forests in temperate eastern North America, especially those of the Mississippi Valley type.* A dense tangle of at least half a dozen species of vines was nearly always in sight, giving the banks in some places, especially where low and swampy, somewhat the appearance of the proverbial tropical jungle. (Many of the species, curiously enough, have near relatives in tropical America.)

The parallel column arrangement brings out the relatively

*See Ann. N. Y. Acad. Sci. 17: 69–73. 1906; Torreya 10: 62. Mr 1910.

greater prevalence of *Platanus, Betula, Hicoria aquatica, Quercus lyrata, Juniperus, Alnus, Onoclea, Aster lateriflorus, Conoclinium, Uniola,* and *Osmunda* in the Cretaceous region, and of *Populus, Pinus glabra, Magnolia grandiflora, Adelia acuminata, Vitis vulpina, Tillandsia, Dianthera, Acuan, Spermacoce, Paspalum mucronatum, Ammannia,* and a few others in the Eocene. All of the former are species of more or less climax tendencies, and all but one or two of them are common above the fall-line, so it is not surprising that they are less frequent coastward. Most of the latter, on the other hand, are confined to the coastal plain, or nearly so. *Alnus rugosa*, common in the Cretaceous, was not noticed in the Eocene region at all, while the reverse is true of *Pinus glabra, Magnolia grandiflora*, and *Acuan illinoense.*

Considering the table as a whole again, it is noteworthy that most of the species seem to have their greatest development (or centers of distribution) in the Mississippi Valley,* and that most of the monocotyledonous and many of the dicotyledonous genera have tropical representatives. The families most largely represented in the table are Compositae, Euphorbiaceae, Leguminosae, Cupuliferae, Cyperaceae, and Gramineae. Such large families as Solanaceae, Labiatae, Gentianaceae, Ericaceae, Umbelliferae, Hypericaceae, Rosaceae, Cruciferae, Caryophyllaceae, Ranunculaceae, Orchidaceae, Liliaceae, and Juncaceae, and such genera as *Viola, Carex, Rynchospora, Scirpus*, and *Panicum*, which are well represented in other parts of Alabama, are scarce or absent on the river banks. About 20 per cent. of the angiosperms are monocotyledons, but perhaps the number of species involved is too small for this fact to be of much significance.

The weeds† along the river furnish an interesting problem. I was surprised to find them so numerous in spots so remote from human habitations and so rarely trod by the foot of man. They are common on all the bluffs, and as many of them are known to have been introduced from foreign countries in comparatively recent times, the vegetation of some parts of the river-banks must present quite a different appearance now from what it did a cen-

* See Ann. N. Y. Acad. Sci. 17: 74. 1906; Torreya 7: 44. 1907.

† By "weed" is here meant a species which grows chiefly in unnatural habitats created by civilization. See Bull. Torrey Club 35: 347. 1908.

tury or two ago. Those which were seen more than twice have already been listed above with the native species, without any attempt to separate them. These will be mentioned again below, together with the less frequent weeds.

For the occurrence of so many weeds (about 40 species were noted on the trip) in such out-of-the-way places the following explanation is suggested: The edaphic conditions on the banks are very diverse, each subdivision of the Cretaceous and Tertiary, as well as the Quaternary second bottoms, furnishing one or more different types of rock or soil, some of which extend only a few feet vertically and a few hundred yards horizontally. In addition to this, the different bluffs face all points of the compass, so that there is a change of environment with every bend in the river. Now if every different formation (and some of them are very different from anything exposed on level ground away from the rivers) had one or more peculiar species adapted to it by processes of evolution, every such river would be bordered by many endemic and very local species. But species (fortunately, one might say) do not seem to be produced quite so freely, and few native plants have been able to grow on the faces of the bluffs at all. The existence of a species confined to a particular kind of river-bluff would be rather precarious, anyway, for the faces of bluffs frequently slough off into the river, destroying all the vegetation on the area affected.

But most weeds are already adapted to diverse soil conditions, and a river is an excellent highway for plants to travel, so that those species which gain access to the river from the fields and settlements along it quickly take possession of the unoccupied bluffs where native plants have been unable to establish themselves. It should not be inferred from this statement however that the bluffs are now completely covered with weeds. A large part of their area is usually too hard or too steep, or crumbling away too rapidly, to afford a foothold for any kind of vegetation, and consequently the bluff weeds are confined chiefly to crevices or to gentle slopes near the base.

Not all of the river-bank weeds are exotics. There seem to be all gradations (if such a thing were possible) between species known to have been introduced from distant parts of the earth and

species which are unquestionably native in the vicinity, as proved by the manner of their occurrence in other habitats. There is no known way of distinguishing which are native and which are introduced species by local observation alone, so recourse must be had to the statements in botanical literature, and those unfortunately are sometimes conflicting. According to the latest and best information obtainable, however, the weeds observed on this trip might be classified roughly according to the origin as follows: (There will of course be room for some difference of opinion here, and further study of the behavior of these plants in other parts of this country and in the tropics is needed.)

1. Species endemic to the Eastern United States, and occurring often in perfectly natural habitats, but also capable of flourishing in weedy places.

Spermacoce glabra, Diodia virginiana, Conobea multifida, Ipomoea lacunosa, Acuan illinoense, Fimbristylis Vahlii, Panicum virgatum, Paspalum mucronatum, Andropogon furcatus.

2. Species supposed to be confined to the Eastern United States, but occurring almost solely in unnatural habitats. Some of these have perhaps never had suspicion cast upon them before, but they will bear watching.*

Spilanthes repens, Xanthium sp., *Diospyros virginiana, Euphorbia humistrata* (and perhaps one or two of its congeners which I could not identify with certainty), *Acalypha virginica, Meibomia* sp. (perhaps more than one), *Glottidium vesicarium, Panicum proliferum.*

3. Species apparently native in the Eastern United States, like those in the first group, but occurring also in tropical America.

Conoclinium coelestinum, Eupatorium serotinum, Tecoma radicans, Ammannia coccinea, Ampelopsis arborea, Commelina hirtella, Fimbristylis autumnalis, Eragrostis hypnoides.

4. Species common to the Eastern United States and the tropics, supposed by most writers to be native here, but chiefly confined to unnatural habitats, like those in the second group.

Eclipta alba, Ambrosia trifida, Physalis angulata, Jussiaea decurrens, Euphorbia nutans, Sesbania macrocarpa, Cebatha Caro-

*Bartram's *Oenothera grandiflora*, whose rediscovery farther down this same river in 1904 created a mild sensation among botanists (see Vail, Torreya 5: 9, 10. 1905), probably belongs to the same class.

lina, Mollugo verticillata, Echinochloa Crus-galli, Tripsacum dactyloides.

5. Species believed to have been introduced from the tropics in modern times. (There seem to be no European weeds along these rivers.)

Cardiospermum Halicacabum, Boerhaavia erecta, Leptochloa mucronata, Eleusine indica, Capriola Dactylon, Sorghum halepense.

No information as to relative frequency or local distribution is given in these five lists, but some of the most abundant weeds are mentioned in the first table. Perennials seem to predominate in the first and third classes and annuals in the fourth, but in the whole list of 40 weeds they are about equal in number.

The following notes on particular species are believed to add something worth knowing to our present stock of information about the distribution of each. Specimens of some of them have already been distributed, and such are indicated by numbers.

CAMPANULA AMERICANA L.

Still in bloom on Oct. 16 near the base of St. Stephens Bluff, Washington County, a perpendicular cliff of "White Limestone" about 75 feet high, which faces nearly north. This species is confined chiefly to the Alleghanies and northward, and had never before been reported so far south.

SICYOS ANGULATUS L.

A common vine on densely wooded alluvial banks; seen on every day of the trip, in every county passed, and perhaps over every formation. Still in bloom. Dr. Mohr does not seem to have seen this in Alabama himself, but he reported it from a single locality in Autauga County, where it was collected by Dr. Smith. I have never met with it in any other southern state.

HOUSTONIA ANGUSTIFOLIA Michx.

This is a comparatively rare species, but pretty widely distributed, with a remarkable range of habitat, from limestone rocks to dry sand, both in Georgia and Alabama. On this trip I found it on St. Stephens Bluff, with *Campanula americana*. Dr. Mohr knew it only from dry ridges.

DIAPEDIUM BRACHIATUM (Pursh) Kuntze.

On shaded alluvial banks, Tuscaloosa, Marengo, and Washington counties, nearly past flowering. This genus is an addition to the known flora of the state.

CONOBEA MULTIFIDA (Michx.) Benth.

On exposed loamy banks of the Tombigbee in Sumter County, near Demopolis (*no. 120*) and Moscow. Nearly past flowering. Dr. Mohr knew this only as a ballast plant in Mobile County, but, where I saw it, it seemed as much at home as any of the other river-bank annuals. However, as stated above, there seems to be no criterion for distinguishing native from introduced species in such places.

NYSSA UNIFLORA Wang.

It is perhaps worth recording that this was not seen on the banks of the river at all, but only in a slough on top of a second-bottom bluff in Marengo County nearly opposite the boundary between Sumter and Choctaw. There it was accompanied by *Taxodium distichum*, as is often the case throughout its range.

THASPIUM BARBINODE CHAPMANI C. & R.

On the limestone on the shaded north side of St. Stephens Bluff. Previously known only from Randolph County, Georgia, and Jackson County, Florida, likewise on Eocene limestone.*

AMMANNIA COCCINEA Rottb.

On wet banks, nearer horizontal than vertical, of soft Eocene rock along the Tombigbee in Sumter, Marengo, Choctaw, Clarke, and Washington counties. Known to Dr. Mohr only from Mobile County.

Acer rubrum L. and *Magnolia glauca* L. were not seen at all, probably because they are chiefly confined to areas much farther from base-level (as a physiographer would term it) than the banks of a large sluggish river.

MENISPERMUM CANADENSE L.

On shaded alluvial banks on both sides of the Tombigbee near the northeastern corner of Choctaw County. This is not men-

*See Bull. Torrey Club 33: 240. 1906; Coulter & Rose, Contr. U. S. Nat. Herb. 7: 148. 1900.

tioned in Mohr's Plant Life of Alabama, but it was later reported from the base of Sand Mountain in Jackson County by T. G. Harbison.* It probably does not extend much farther south than where I saw it.

ADICEA PUMILA (L.) Raf.

On shaded alluvial bank near Beckley's Landing, Marengo County, and in rich shady woods near Hatchetigbee Bluff, Washington County; accompanied by the somewhat similar *Urticastrum divaricatum* at both places. Apparently not reported from the coastal plain of Alabama before.

FIMBRISTYLIS VAHLII (Lam.) Link.

Rather common on exposed loamy banks, considerably below high-water mark, in Greene, Hale, Sumter, Marengo, and Clarke counties. (*Nos. 117, 118.*) This neat little plant evidently cannot stand, or does not have, much competition, for it grows in scattered tufts, unobstructed by other vegetation. A study of its life-history would doubtless bring out some interesting things. As the places where it grows are often under water, its periods of vegetative activity must be subject to considerable interruption.† To offset this, it seems to have a habit of sending up several successive crops of culms during the season, and of course if any one crop succeeds in maturing seed its purpose is accomplished. Some of the specimens collected show two sets of culms of different ages, perhaps a month or two apart.

Not very much is known about the range and habitat of this species. It is rarely mentioned outside of manuals and monographs, and I had never seen it growing before this time and have not seen it since. Its name does not appear in Mohr's Plant Life of Alabama, but singularly enough there is a specimen of it in the Mohr Herbarium at the University of Alabama, from "Damp allu-

* Biltmore Bot. Stud. 1: 155. 1902.

† See notes on one of its near relatives, *F. perpusilla*, in Bull. Torrey Club 31: 17–19. 1904. *F. autumnalis* seems to have similar struggles for existence in some places. Very minute specimens of the latter, some not more than an inch tall, but fruiting, were collected on the muddy bottom of a shallow dried-up pond about a mile west of Black Buff, Sumter County, on October 12 (*no. 122*). See also in this connection Fernald in Rhodora 11: 180. S 1909.

uvial banks, Chastang's Bluff, Sept. 1, 1879," labeled "*Stenophyllus Stenophyllus*"!

HEMICARPHA MICRANTHA (Vahl) Pax.

Seen only on a gentle slope of soft shale (Black Bluff formation), perpetually moistened by water trickling down from the second-bottom deposits a few feet higher up, just below Beckley's Landing, a mile or two north of Myrtlewood, Marengo County, Oct. 13 (*no. 123*). The bulk of the vegetation in this habitat consisted of *Dianthera americana* and various Cyperaceae, one more of which is mentioned below.

This is another species which I have never seen elsewhere in the South. Dr. Mohr reported it from "Low, damp sandy ground, most frequent in flat open grassy pine barrens" (which by the way would be a very unusual habitat for *Hemicarpha*), in Washington, Clarke, and Mobile counties; but the only specimen so labeled in his herbarium at the University (and I am informed that a similar state of affairs exists in his other collection, now deposited in the U. S. National Herbarium), from "Close damp soil, pastures, etc. Mobile. April, May," is *Scirpus carinatus*!*

CYPERUS INFLEXUS Muhl.

Collected at the same time and place as the preceding (*no. 124*), and seen also at Jackson landing, where our river trip terminated. The occurrence of this species in Alabama was not known until I found it on Lookout Mountain in the fall of 1905,† (or in Georgia until I found it on flat granite rocks in Clarke and Clayton counties in the summer of 1900).

HOMALOCENCHRUS LENTICULARIS (Michx.) Scribn.

In wide densely wooded alluvial bottoms, about two miles west of Myrtlewood and the same distance from the Tombigbee River,

* For notes on the occurrence of this species in Alabama, see Bull. Torrey Club 33: 525. 1906.

† See Torreya 6: 115. 1906. It is rather a curious coincidence that I should have been the first to find this species and the preceding in Worcester County, Massachusetts, after two or three floras of the county had been published. (See Rhodora 1: 201, 202. 1899.) There they both grow on the sandy shores of two lakes in Brookfield. For other interesting notes on their occurrence together see Haberer, Rhodora 2: 61. 1900; Blankinship, Rhodora 5: 130. 1903; Fernald, Rhodora 11. 220. 1909; Wiegand, Rhodora 12: 39. 1910.

in Marengo County, Oct. 14. Not previously reported from Alabama.

PASPALUM MUCRONATUM Muhl. (*P. fluitans* Kunth).

Not rare, on shaded alluvial banks, Tuscaloosa (*no. 116*), Sumter, Marengo, Choctaw, and Washington counties. This, too, was new to the known flora of the state.

PINUS PALUSTRIS Mill.

The only places between Tuscaloosa and Jackson where this is visible from the river seem to be the crests of the high Buhrstone ridges or "mountains" above mentioned, in Choctaw and Clarke counties. There a few specimens of this unmistakable pine could barely be distinguished with the naked eye as we floated along. It also grows to some extent on the hills capped with Lafayette red loam around Jackson.

? EQUISETUM ARVENSE L.

Sterile specimens which cannot be distinguished from this species were collected in damp crevices of Ripley (Cretaceous) limestone at Barton's Bluff in Marengo County, about ten miles below Demopolis (*no. 121*). This is just the kind of a place in which one usually finds Equisetums (mostly of the *hyemale* group) in the South, but the finding of *E. arvense* in Alabama was decidedly unexpected. Dr. Gattinger reported it from "moist fields, Cave Spring, E. Tenn.," and Dr. Small in his Flora of the Southeastern U. S. credited it to North Carolina, without definite locality, but these are the only records of its occurrence in the southeastern states that I have found. *E. arvense* in the North is often if not usually a weed, but these specimens appeared decidedly native.

Perhaps if my locality could be visited in spring when the fertile stems are visible this plant would turn out to be something else than *E. arvense;* but it is certainly not one of the three species credited to Alabama by Dr. Mohr, for those are all of the *hyemale* group.

ASPLENIUM ANGUSTIFOLIUM Michx.

Many fine specimens of this, some fruiting (*no. 129*), were found in rich shady woods on the north side of a steep Buhrstone

FIGURE 2. Rich shady woods, with *Asplenium angustifolium*, etc., on north side of Hatchetigbee Bluff, Washington County, Alabama, October 16, 1908.

hill rising over 100 feet above the river at Hatchetigbee Landing, Washington County, on the last day of the trip. (See illustration—FIGURE 2.) This was quite a surprise, as the southern limit of this species was previously supposed to be in the mountains of Winston County, about 160 miles farther north and 1,500 feet higher. (The fact that several of the smaller tributaries of the Warrior River flow through Winston County may have something to do with the occurrence of this fern on the Tombigbee.)

At the same time and place I noticed *Scrophularia marilandica*, *Phryma Leptostachya*, *Adicea pumila*, and *Phegopteris hexagonoptera*, which were not known from the coastal plain of Alabama before, and *Panax quinquefolium*, which here reaches just about its southern limit.

TALLAHASSEE, FLORIDA.

Studies on the Rocky Mountain flora—XXI

PER AXEL RYDBERG

Ambrosia media sp. nov.

Annual; stem 4–6 dm. high, hispid with ascending or appressed short hairs, more or less strigose, branched; leaves pinnately divided, thick, 5–10 cm. long, scabrous and glandular-granuliferous above, hispid-strigulose beneath, all except the uppermost with shorter or longer, hirsute-ciliate, narrowly winged petioles; divisions oblong or lanceolate, usually more or less cleft or toothed, the lobes or teeth lanceolate, acute; staminate racemes rather dense; involucre nodding, slightly lobed with 5 rounded lobes and crenulate, 4–5 mm. in diameter, hispid-strigose; hairs about 0.5 mm. long, with more or less pustulate bases; receptacle with few narrow lance-subulate scales; fruit obovoid; body about 3 mm. long, puberulent or in age glabrate, with 5–7 sharp spines 0.5 mm. long and strongly directed forward; beak about 1 mm. long, pubescent.

In the form and texture of the foliage, this species resembles *A. coronopifolia* T. & G. (*A. psilostachya* of most authors) as closely as to make it almost impossible to distinguish the two by the leaves alone, the only difference being that the leaves of *A. media* are more inclined to be petioled and the petioles distinctly hispid-ciliate. Otherwise, the plant is more closely related to *A. elatior* and *A. artemisiifolia*, the root being annual and the fruit spiny. *A. coronopifolia* has a larger fruit, which is inclined to be round-elliptic instead of obovoid, is more pubescent, without spines, either perfectly smooth or rarely with small rounded tubercles.

COLORADO: Fort Collins, Aug. 27, 1885, *C. S. Crandall* (type, in herb. N. Y. Bot. Gard.).

NEW MEXICO: Pecos, San Miguel County, Aug. 20, 1898, *Standley 5138*; Kingston, 1904, *Metcalfe 1337* (?).

COAHUILA: Saltillo 1898, *Palmer 293*.

MONTANA: Sand Coulee, Sept. 7, 1885, *R. S. Williams*.

NEBRASKA: Chadron, Oct. 9, 1897, *J. M. Bates 706* (plants predominantly pistillate).

Grindelia integerrima sp. nov.

Perennial, with a cespitose base; stems about 3 dm. high, glabrous, somewhat angled by the decurrent lines; leaves narrowly oblanceolate, 2–4 cm. long, acute, strongly resinous-dotted, entire; heads numerous, corymbose; involucre about 7 mm. high and 1 cm. wide; bracts lanceolate, with very short, terete, squarrose tips; ligules 6–7 mm. long; pappus-bristles slightly flattened, curved and twisted, 3 mm. long, about the length of the achenes.

This somewhat resembles *Grindelia nana* in general habit but differs in the broader bracts with much shorter tips and the strongly curved and twisted pappus-bristles.

IDAHO: Sandy soil near Granite Station, Kootenai County, July 29, 1892, *Sandberg, MacDougal, & Heller 784* (type, in herb. N. Y. Bot. Gard.).

Grindelia columbiana (Piper) Rydb. comb. nov.

Grindelia discoidea Nutt. Trans. Am. Phil. Soc. **7**: 315. 1840. Not *G. discoidea* H. & A. 1836.

Grindelia nana discoidea A. Gray, Syn. Fl. **1**^{2}: 119. 1884.

Grindelia nana columbiana Piper, Contr. U. S. Nat. Herb. **11**: 556. 1906.

Chrysopsis angustifolia sp. nov.

Chrysopsis stenophylla Britt. & Brown, Ill. Fl. **3**: 327. 1898. Not *C. stenophylla* (A. Gray) Greene. 1884.

Perennial, with a cespitose caudex; stems erect, 2–4 dm. high, canescent and more or less hirsute; leaves narrowly linear-oblanceolate, the lower short-petioled, the upper sessile, 2–5 cm. long, 2–5 mm. wide, acute, grayish-strigose on both sides, somewhat hispid-ciliate on the lower portion; involucres turbinate-campanulate, 8–10 mm. high and about as broad; bracts narrow and linear, acute, grayish-strigose; rays about 1 cm. long; achenes canescent; outer pappus of short bristles; inner pappus-bristles tawny.

This is intermediate between *Chrysopsis foliosa* and *C. stenophylla*. It resembles the latter in leaf-form but differs in being more canescent, less hispid, not at all viscid, and in the bracts, which are narrower, and strigose-canescent instead of hispid and viscid-puberulent. From *C. foliosa* it differs in the narrower, spreading leaves, the more distinctly peduncled heads, and less white pubescence.

NEBRASKA: Middle Loup River, near Mullen, Hooker County, Sept. 14, 1893, *P. A. Rydberg 1766* (type, in herb. N. Y. Bot. Gard. and Columbia Univ.); Long Pine, Sept. 14, 1890, *J. M. Bates;* Deuel County, Aug. 24, 1891, *Rydberg 149.*

KANSAS: Kiowa County, Sept. 4, 1898, *L. F. Ward.*

ALBERTA: Vicinity of Banff, Aug. 14, 1899, *McCalla 2032,* in part.

Chrysopsis Butleri sp. nov.

Perennial; stem decumbent at the base or erect, grayish-hispidulous and slightly hirsute; leaves 1–3 cm. long, the lower obovate, the upper oblong or elliptic, obtuse or apiculate, often spreading, sessile, grayish-hirsute with short hairs; heads pedunculed but usually subtended by an oblong small leaf; involucres 8 mm. high, 10–15 mm. broad; bracts linear, acute, hirsutulous, but not at all glandular or viscid; ligules about 8 mm. long; achenes silky-strigose; pappus tawny, the outer of minute bristles.

This species is characterized by the small, obovate or elliptic, subsessile leaves, which are often spreading and with short spreading pubescence. Nearly all the species of the *Chrysopsis villosa* group, with spreading pubescence, are more or less viscid or glandular, but this is not at all the case with *C. Butleri.* In leaf-form it resembles *C. villosa,* but both leaves and heads are smaller and the pubescence is different. In *C. villosa* the hairs are at least in the young state appressed.

MONTANA: Gateway, Aug. 17, 1908, *B. T. Butler 620* (type, in herb. N. Y. Bot. Gard.); Midvale, Sept. 3, 1901, *Umbach 564;* Wild Horse Island, Aug. 13, 1908, *Butler 480, 481, 485, 491.*

WYOMING: Near Fort Laramie, 1842, *Fremont 482.*

UTAH: City Creek Cañon, 1875, *M. E. Jones;* same locality, Oct. 7, 1905, *Garrett 1703.*

Chrysopsis grandis sp. nov.

Perennial, with a cespitose caudex; stems about 3 dm. high, leafy, long-hirsute, hispidulous and resinous-granuliferous; leaves spatulate or oblanceolate, 3–5 cm. long, the lower petioled, the upper sessile, hirsute or hispid and conspicuously resinous-granuliferous, apiculate; heads corymbose, short-peduncled, rarely subtended by a small leaf; involucres 8 mm. high, 12–18 mm. broad; bracts densely hirsute, only slightly granuliferous; rays golden yellow, about 1 cm. long; achenes strigose; pappus yellowish tawny, the outer of short bristles.

This species is related to *Chrysopsis hispida* and *C. columbiana*, but differs from both in the larger heads; it differs also from the former in the more copious pubescence and the more decidedly oblanceolate and petioled leaves; from the latter in the longer pubescence, the more copious resinous granules and the more decidedly petioled leaves.

MONTANA: Jocko Creek, June 16, 1901, *MacDougal 275* (type, in herb. N. Y. Bot. Gard.); also *265*.

Chrysopsis barbata sp. nov.

Perennial; stems about 3 dm. high, more or less tinged with purplish or red, hirsute with long white hairs and somewhat puberulent; leaves sessile, lanceolate, 3–5 cm. long, the upper acuminate, long-hirsute and somewhat resinous-granuliferous; heads subsessile; involucres 1 cm. high and 12–15 mm. broad; bracts linear, acute, sparingly long-hirsute and resinous-granuliferous; ligules about 7 mm. long, golden yellow; achenes strigose; pappus brownish tawny, the outer squamulate, 1–1.5 mm. long.

This species is related to *Chrysopsis hispida* but differs in the long, dense pubescence, a much less abundance of resinous granules, larger leaves and heads, and more conspicuous outer pappus. It grows on sandy plains.

IDAHO: Valley of Spokane River, Kootenai County, July 17, 1893, *Sandberg, MacDougal, & Heller 664* (type, in herb. N. Y. Bot. Gard.).

Chrysothamnus attenuatus (Jones) Rydb. sp. nov.

Bigelovia Howardi attenuata Jones, Bull. Calif. Acad. Sci. II. **5**: 691. 1895.

Chrysothamnus affinis attenuatus A. Nels. Bot. Gaz. **28**: 374. 1899.

Chrysothamnus salicifolius sp. nov.

A shrub 3–10 dm. high; branches erect, white or gray, finely pannose-tomentulose; leaves linear, 3-nerved, 4–6 cm. long, 3–6 mm. wide, minutely tomentulose; heads in a dense corymbiform cyme; involucres 7–8 mm. long; bracts elliptic, oval or ovate, the outer acutish, the inner obtuse or rounded at the apex, eroseciliate, the outer slightly tomentose, the inner glabrous; corollas about 1 cm. long; teeth 1.5–2 mm. long, lanceolate, obtusish; achenes coarsely strigose, angled.

This species resembles *Chrysothamnus graveolens* in habit, but the leaves are broader, more tomentulose; the bracts are slightly tomentulose, erose-ciliate, and broader than in that species. Ward's specimens were determined by Dr. Gray as *Bigelovia graveolens latisquamea* and included therein in the Synoptical Flora; but it is wholly distinct therefrom. The true *C. latisquamea* (A. Gray) Greene has very white filiform-revolute leaves and the bracts more rounded at the apex.

UTAH: Strawberry Valley, Sept. 3, 1883, *F. E. Leonard 288* (type, in herb. N. Y. Bot. Gard.); Twelve-mile-Creek, Aug. 29, 1875, *L. F. Ward 659*.

Chrysothamnus stenolepis sp. nov.

Low shrub, 2–3 dm. high, somewhat spinescent; branches short, erect, glabrous or finely puberulent above; leaves narrowly lance-linear, 1–2 cm. long, 2–4 mm. wide, glabrous, scabrous-ciliate on the margins, convolute and somewhat twisted; inflorescence corymbiform, of few heads; involucres about 8 mm. long; bracts 4-ranked in 3 series, narrowly lanceolate, or the inner linear, acute, glabrous, keeled, somewhat viscid; corollas scarcely exceeding the involucre; lobes lanceolate, 2 mm. long; achenes hirsute-strigose.

This species is related to *Chrysothamnus viscidiflorus* and *C. glaucus*, but differs from both in the very narrow acute bracts.

MONTANA: Pass Creek, near Bridger Pass, *H. Engelmann* (type, in herb. Columbia Univ.).

UTAH: Saleratus River, Aug. 1889, *C. K. Dodge*.

Chrysothamnus marianus sp. nov.

Undershrub, 1–2 dm. high, with a woody thick caudex; branches erect, at first green, soon straw-colored or white, densely and finely puberulent; leaves linear or the lower linear-oblanceolate, acute, thick, densely puberulent, 1–2 cm. long, 1–15 mm. wide, 1-nerved, somewhat twisted; heads narrow, in small, corymbiform-cymose panicles, involucres about 5 mm. high; bracts yellowish, glutinous, erose-ciliate on the margins, 4-ranked and in about 3 series, the outer ovate, acutish, the inner spatulate-oblong, rounded at the apex; achenes sparingly strigose; corollas scarcely exceeding the involucres.

This species has many characters of *Chrysothamnus puberulus*,

but differs in the more yellowish-green herbage, the whiter stems, the narrower, more erect, thick, 1-nerved instead of 3-nerved leaves, the finer pubescence, and the involucres, which are narrower and with different bracts. In *C. puberulus* the inner bracts are linear or linear-lanceolate and acute. The young achenes are only slightly strigose, in which respect it approaches *C. Bakeri* and *C. Vaseyi*.

UTAH: Along Sevier River, below Marysvale, July 20, 1905, *Rydberg & Carlton 6993* (type, in herb. N. Y. Bot. Gard.); also *6983;* Mount Barette, July 26, *7253*.

SOLIDAGO MISSOURIENSIS Nutt. Jour. Acad. Phila. 7: 32. 1834

Solidago Tolmieana A. Gray, Syn. Fl. 1[1]: 151. 1884.

Dr. Gray in the original publication of *S. Tolmieana* adds the following note: "Has been taken for a form of *S. missouriensis* var. *montana;*" but he overlooked the fact that it was identical with the original *S. missouriensis*. He might have been led astray by Nuttall himself, who later included in *S. missouriensis* the common plant of the upper Missouri Basin with recurved secund branches. That the latter is not the original *S. missouriensis* may be seen from Nuttall's diagnosis, of which I here give a copy:

"55 SOLIDAGO * *missouriensis*. Pumila, glabra, racemis erectis, foliis lineari-lanceolatis, acutis, inciso-subserrulatis, superioribus integris, panicula brevi laxa, floribus majusculis."

"Stem slender, smooth, leafy, about a foot or so high. Leaves scabrous at the margin. Panicle about three inches long, the branches slender, the flowers pedicellate, and brought together in a somewhat rhomboidal raceme. Rays as long as the calyx."

This agrees with *S. Tolmieana* but not with the plant described by Gray as *S. missouriensis*.

The original *Solidago missouriensis* was collected by Wyeth on the upper branches of the Missouri. There is a specimen of this collection in the Torrey Herbarium which agrees with the description and this matches very well the type of *S. Tolmieana* in the Gray Herbarium. The plant described by Gray as *S. missouriensis* is characterized by its flat-topped or round-topped inflorescence with recurved-spreading, secund branches, in variance with Nuttall's characterization: "racemis *erectis*," and "the flow-

ers pedicellate, and *brought together* in a somewhat rhomboidal *raceme*." The synonymy of Gray's plant is as follows:

SOLIDAGO GLABERRIMA Martens, Bull. Acad. Brux. **8**: 68. 1841

Solidago missouriensis Nutt. Trans. Am. Phil. Soc. II. **7**: 327, in part. 1840. Not *S. missouriensis* Nutt. 1834.

Solidago missouriensis A. Gray, Syn. Fl. **1**^{2}: 155. 1884.

Solidago serotina Hook. Comp. Bot. Mag. **1**: 97. 1835. Not *S. serotina* Ait. 1789.

Solidago glaucophylla sp. nov.

Perennial, with a branching rootstock; stems slender, pale, glabrous up to the sparingly pubescent inflorescence; leaves glabrous, glaucous, minutely ciliolate on the margins, rather thick, linear-oblanceolate or the upper linear, triple-nerved, 6–10 cm. long, 4–10 mm. wide, entire, acute; inflorescence a round-topped panicle, the branches somewhat recurved-spreading and somewhat secund; heads about 5 mm. high; bracts oblong, obtuse, or the outer lance-oblong, acutish; rays short, 2–2.5 mm. long, 0.7–0.8 mm. wide; achenes slightly strigose-hirsute.

This species is related to *Solidago missouriensis* and *S. glaberrima*, but differs from both in the narrow, entire, glaucous leaves and the thicker, oblong and obtuse instead of linear-lanceolate and acute bracts. The type grew on dry plains at an altitude of 1000 m.

MONTANA: Dry plains near Kalispel, Flathead Valley, July 25, 1901, *MacDougal 760* (type, in herb. N. Y. Bot. Gard.).

WYOMING: Buffalo, July 25, 1896, *A. Nelson 2501* (?, similar but with narrower inflorescence).

Solidago nivea sp. nov.

Perennial, with a woody cespitose rootstock and short caudex; stems 1–2 dm. high, decumbent at the base, canescent-puberulent; basal leaves 2–4 cm. long, short-petioled; blades obovate-spatulate, rounded at the apex, entire or nearly so; stem-leaves oblanceolate, sessile, the upper acutish; all leaves thick, densely canescent-puberulent, almost velvety and almost white; inflorescence a flat-topped corymbiform panicle; heads slightly nodding at first, but not secund on the branches, about 6 mm. high;

bracts yellowish with a greenish midrib, lanceolate and acute; achenes hirsute-strigose; ligules 3 mm. long and nearly 1 mm. wide.

This is closely related to *Solidago nana*, but differs in the narrower, lanceolate, and acute bracts. Its pubescence is usually also denser and whiter. Platt's specimens were labeled *S. missouriensis* v. *montana* Gray, to which it has no relationship, only resembling it a little in habit and in the narrow bracts.

MONTANA: Lima, Aug., 1905, *Rydberg 2804* (type, in herb. N. Y. Bot. Gard.); Hot Sulphur Springs, July 24, 1871, *W. B. Platt.*

Solidago Garrettii sp. nov.

Perennial, with a creeping rootstock; stem 2–3 dm. high, sparingly puberulent or glabrous; leaves obovate-spatulate or the upper oval, entire or the lower toothed towards the apex, rather thin, triple-nerved, minutely and sparingly scabrous-puberulent or nearly glabrate, scabrous-ciliolate on the margins, 3–6 cm. long; inflorescence more or less leafy, with a few secund branches; heads 5–6 mm. high; bracts lanceolate, acute, yellowish; ligules 2 mm. long and fully 0.5 mm. wide, golden yellow; achenes sparingly hirsute.

This species is related to *Solidago mollis*, *S. radulina*, and *S. Radula*. It differs from the first in the thinner, green, more decidedly obovate, and sparingly pubescent leaves, and the open, few-branched panicle; from *S. radulina* in the larger, thinner leaves, the open and more leafy inflorescence, and the acute instead of obtuse bracts; and from *S. Radula* in the thin, broad leaves, large, ample upper stem-leaves, the small inflorescence, and acute bracts.

UTAH: Big Cottonwood Cañon, Aug. 28, 1906, *A. O. Garrett 2041* (type, in herb. N. Y. Bot. Gard.); same locality and collector, Aug. 14, 1905, *1608*, and Aug. 5, 1905, *1587*.

WYOMING: Headwaters of Cliff Creek, Aug. 9–18, 1900, *C. C. Curtis.*

ASTER RICHARDSONII Sprengel, Syst. **3**: 528. 1826

Aster montanus Richards. App. Frankl. Journ. 749. 1823. Not *A. montanus* Nuttall. 1818.

Aster salsuginosus Less. Linnaea **6**: 124. 1831. Not *A. salsuginosus* Richards. 1823.

Aster Richardsonii, var. *gigantea* Hook. Fl. Bor.-Am. **2**: 7. 1834.
Aster sibiricus giganteus A. Gray, Syn. Fl. 1^2: 177. 1884.
Aster giganteus Rydb. Bull. N. Y. Bot. Gard. **2**: 184. 1901.

In describing *Aster meritus*,* Professor Aven Nelson evidently was correct in referring the name *A. Richardsonii* Spreng. to the subarctic species, characterized by the densely villous peduncles and involucres, which the writer has named *A. giganteus*. Richardson collected both, as shown by specimens in the Columbia University herbarium, and evidently included both under the name *A. montanus*, but his description applies only to the plant which Hooker afterwards named and described as *A. Richardsonii*, var. *gigantea*. There are, however, two points in Professor Nelson's discussion which are a little erroneous, ambiguous, and unclear, wherefore I add the following.

Professor Nelson has made the following remarks: "It is equally clear that *A. Richardsonii* is the name given to the *A. montanus* Nutt." If this was true, *A. Richardsonii* should be a synonym of *A. sericeus montanus* of the Southern States, and I received that impression when I read Professor Nelson's discussion. Evidently this was not Professor Nelson's intention. He evidently meant *A. montanus* Richardson.

From Professor Nelson's discussion, one also gets the impression that *A. meritus* Nels. is not found in the subarctic regions, and is a plant of the Rocky Mountains only, but this is not the fact. The specimens regarded as *A. Richardsonii* by Hooker and cited in his Flora, as collected in the "barren country from lat. 64° to the Arctic Seas" belong to *A. meritus*. Two of Richardson's specimens are in the herbarium of Columbia University. These cannot be distinguished from Nelson's *nos. 2334* and *6610* cited under *A. meritus*.

As said before, Richardson collected both plants. Hooker was the first one to distinguish them and made one the species, the other the variety of *A. Richardsonii* Spreng., as *A. montanus* Richardson was not available on account of the older *A. montanus* Nutt., *A. Richardsonii* Spreng. being only a substitute for the former. Under ordinary circumstances, we should have followed Hooker's interpretation and used *A. Richardsonii* for the short-pubescent

* Bot. Gaz. **37**: 268. 1904.

plant. The writer made such a ruling in 1901, when he raised *A. Richardsonii*, var. *gigantea* to specific rank. But it is evident from Richardson's description that his *A. montanus* characterized rather the more villous-tomentose plant. Not only was Sprengel's *A. Richardsonii* based upon *A. montanus* Richardson, but his description also characterizes Hooker's var. *gigantea*.

The synonymy of the more southern plant is as follows:

ASTER MERITUS A. Nelson, Bot. Gaz. **37**: 269. 1904

Aster montanus Richardson, App. Frankl. Journ. 32, in part (?). 1823.

Aster Richardsonii Hook. Fl. Bor.-Am. **2**: 7. 1834. Not *A. Richardsonii* Spreng. 1826.

Aster sibiricus A. Gray, Syn. Fl. **1**^{2}: 176. 1884. Not *A. sibiricus* L. 1753.

Aster Williamsii sp. nov.

Perennial, with cespitose rootstock; stems erect, about 3 dm. high, more or less villous; leaves oblanceolate, 3–10 cm. long, the lower petioled, the upper sessile, finely villous on both sides; heads few in a corymbiform inflorescence; involucres 8 mm. high, 1 cm. broad; bracts linear or lance-linear, acute, sparingly and finely villous on the back, slightly scarious-margined below, imbricate in 3 series; rays lilac, about 1 cm. long; achenes sparingly and finely pilose; pappus tawny.

This species is somewhat intermediate between *Aster andinus* and *A. meritus*. From the former it differs in the taller and more slender, erect stem, the finely villous leaves, the shorter, more numerous and more pubescent involucral bracts; and from the latter in the narrower leaves, which are always entire, in the comparatively higher involucre, and the narrower bracts.

WYOMING: Dry hills, North Fork of Clear Creek, Big Horn Mountains, Aug. 12, 1898, *T. A. Williams* (type, in herb. N. Y. Bot. Gard.); eastern slope of Big Horn Mountains, headwaters of Clear Creek and Crazy Woman River, July 20–Aug. 15, 1900, *Tweedy 3096A*.

Aster Macounii sp. nov.

Perennial, with a rootstock; stem 3–6 dm. high, sparingly hispid-strigose, purple-tinged; leaves thick, oblanceolate or lanceolate, 2–8 cm. long, hispidulous-ciliate, otherwise glabrous; in-

florescence corymbiform; heads solitary on branches with lanceolate bract-like leaves; involucre 8–10 mm. high, 12–15 mm. broad; bracts oblanceolate, squarrose, acute and spinulose-tipped, pubescent on the back and ciliate on the margins; rays 7–8 mm. long, rose-colored; achenes strigose, pappus pinkish tawny.

This species combines the characters of two different groups of asters. It has the habit, leaves, middle-sized heads, pappus, and pubescence of the bracts of *Aster Nelsonii*, *A. griseus*, and their allies, but has the spinulose- or callus-tipped bracts and upper leaves of *A. multiflorus*, *A commutatus*, etc.

CANADA: Old Wives Lake, Northwest Territory [Keewatin], July, 1880, *John Macoun* (type, in herb. Columbia Univ.).

ASTER LINDLEYANUS T. & G. Fl. N. Am. **2**: 122. 1841

Aster paniculatus, var. *δ* Lindl. in Hook. Fl. Bor.-Am. **2**: 8. 1834.

Dr. Gray in his Synoptical Flora* stated: "The original of this species was raised by Gordon from Labrador seeds and has more extended inflorescence of smaller heads than is common in the wild plant." Dr. Gray evidently referred to *Aster paniculatus* Ait.;† however, *A. Lindleyanus* was not based on *A. paniculatus* Ait., but principally on *A. paniculatus*, var. *δ* of Lindley in Hooker's Flora, although *A. paniculatus* of the same work was partly included. The var. *δ* was collected by Richardson near Slave Lake. Whether this plant is the same as *A. paniculatus* Ait. is very doubtful. *Aster Lindleyanus* has been reported from many stations in eastern North America as far south as Ohio, but the eastern plant differs somewhat from that of the Mackenzie basin and the northern Rockies in thinner more decidedly cordate basal leaves, and in its bracts with more conspicuous green tips. As these differences are hardly specific it is best to leave the eastern plant in *A. Lindleyanus*. In the northern Rockies and the Saskatchewan region there are found plants which have been referred to *A. Lindleyanus* but which the writer thinks are distinct. They can be distinguished as follows:

Basal leaf-blades cordate or broadly ovate; upper stem-leaves lanceolate; achenes glabrous.
Petioles, midribs, and usually also the stem pubescent with long white hairs..... *A. Wilsonii.*

* 1²: 182. 1884.

† Hort. Kew. 3: 207. 1789.

Plant glabrous or sparingly short-pubescent ..... *A. Lindleyanus.*
Basal leaf-blades lanceolate; upper stem-leaves narrowly lanceolate or those of the inflorescence lance-linear.
Heads few; involucres 8–9 mm. high; rays about 15 mm. long; achenes glabrous ..... *A. MacCallae.*
Heads numerous; involucres 5–6 mm. high; rays 8–10 mm. long; achenes hispidulous-strigose ..... *A. Butleri.*

Aster Wilsonii sp. nov.

Aster Lindleyanus β T. & G. Fl. N. Am. **2**: 122. 1841.

Perennial, with a horizontal rootstock; stem 3–6 dm. high often purplish, more or less pubescent with long white, curved, somewhat deciduous hairs; basal leaves petioled; petioles 5–10 cm. long, densely white-ciliate, together with the midrib; blades ovate or subcordate, 5–10 cm. long, usually more or less hirsute on both sides, but in age glabrate, serrate, acuminate at the apex; the lower stem-leaves similar; the upper lanceolate, sessile, subentire or those of the paniculate inflorescence narrowly lanceolate; involucre 7–8 mm. high, scarcely 1 cm. wide; bracts subulate, attenuate, with a green midrib which widens somewhat above the middle; rays 8–10 mm. long, bluish purple; pappus tawny; achenes glabrous.

This species is related to *Aster Lindleyanus* and may grade into it, but the typical specimens are very distinct, characterized by the long white hairs on the petioles, midribs, and often the stem, by the narrower upper leaves, the smaller heads, and the more ascending branches.

BRITISH COLUMBIA: Armstrong, 1904, *E. Wilson 419* (type, in herb. N. Y. Bot. Gard.); also *414*, *416*, and *393*.

ALBERTA: Grattan Creek, Aug. 16, 1906, *Macoun & Herriot 77073;* also Edmonton, Aug. 26, 1906, *77074*.

WESTERN ONTARIO: Fort Williams, Sept. 7, 1889, *Dr. and Mrs. N. L. Britton and Miss Millie Timmerman.*

MACKENZIE: Fort Resolution and Mackenzie River, 1861–2, *R. Kennicott.*

Aster MacCallae sp. nov.

(?) *Aster praecox* Lindl. in Hook. Fl. Bor.-Am. **2**: 9. 1834. Not *A. praecox* Willd. 1813.

Perennial, with a horizontal rootstock; stems 3–6 dm. high, often purplish, glabrous up to the inflorescence, the branches of which are slightly pubescent in lines; lower leaves with winged

petioles, which are slightly dilated and ciliate at the base; blades broadly lanceolate, 8–15 cm. long, usually more or less serrate with ascending teeth, acute, glabrous or essentially so, hispidulous-ciliolate on the margins, rather thick; upper leaves lanceolate, sessile or those of the inflorescence lance-linear; inflorescence or its few principal branches racemiform; involucres 8–9 mm. high, 1 cm. broad; bracts subulate, glabrous, with linear-lanceolate green tips and green midveins below; rays blue or bluish purple, about 15 mm. long; disk-flowers red-purple; achenes glabrous, at least in age.

This may be the *A. praecox* of Hooker's Flora Boreali-Americana; but the name is preoccupied by *A. praecox* Willd. It is related to *A. Lindleyanus*, but differs in the narrower leaves, of which the lower are neither cordate nor broadly ovate and those of the inflorescence are lance-linear, in the larger rays, which are about 15 mm. long, and in the more ascending branches of the simpler inflorescence.

ALBERTA: Along streams, edge of woods on the Sulphur Mountain, Aug. 16, 1899, *McCalla 2026* (type, in herb. N. Y. Bot. Gard.); roadside, Spray Avenue, Banff, Sept. 18, 1899, *McCalla 2027*; below Wapta Lake, Aug. 6, 1904, *J. Macoun 69480*; gravelly banks, Second Lake, Rocky Mountain Park, Aug. 3, 1891, *Macoun 7770*.

Aster Butleri sp. nov.

Perennial, with a horizontal rootstock; stem 4–10 dm. high, glabrous, slender; lower leaves petioled; blades lanceolate, about 1 dm. long, distantly serrate with ascending teeth, hispidulous-ciliolate on the margins, otherwise glabrous; upper stem-leaves sessile, narrowly lanceolate, or those of the inflorescence lance-linear, entire; inflorescence paniculate with numerous heads; involucres 5–6 mm. high. about 8 mm. wide; bracts subulate, with green midribs and narrowly lanceolate green tips, attenuate, glabrous; rays bluish purple, 8–10 mm. long; achenes hispidulous-strigose.

This is related to the preceding, but differs from it in the large inflorescence with numerous small heads, and in the pubescent achenes. In the latter respect it differs from all the species of the *Aster Lindleyanus* group.

MONTANA: Gateway, Aug. 16, 1908, *B. T. Butler 443* (type, in herb. N. Y. Bot. Gard.); also *433*.

ALBERTA: Field, Aug. 28, 1904, *J. Macoun 65485*.

BRITISH COLUMBIA: Flood plains of Columbia at Beavermouth, Aug. 18, 1905, *C. H. Shaw 1165*; Armstrong, 1904, *E. Wilson 422* (?); Emerald Lake, Aug. 30, 1904, *J. Macoun 65488* (in part).

Aster subsalignus sp. nov.

Perennial, with a rootstock; stem glabrous throughout, 6–10 dm. high; leaves nearly erect, glabrous, glaucous, entire, clasping but scarcely auricled, 5–10 cm. long, narrowly linear, 6–7 mm. wide, or the lower narrowly linear-oblanceolate, or those of the branches lance-linear and reduced; inflorescence paniculate; involucres about 7 mm. high and 8 mm. wide; bracts linear or the outer linear-lanceolate, glabrous, acute, with a green midrib and narrowly lanceolate green tip, or the outer nearly wholly green; rays bluish or bluish purple, about 8 mm. long; achenes glabrous; pappus tawny; disk-flowers dark, red-purple.

This is related to *Aster Geyeri*, but differs in the narrow leaves, scarcely auricled at the base; they are also more erect or strongly ascending and wholly entire. It stands in the same relation to *Aster Geyeri* as *A. virgatus* and *A. concinnus* do to *A. laevis*. It has the narrow green tips of the bracts found in *A. Geyeri* but not in the others. The spreading branches of the inflorescence with their very small bract-like leaves characteristic of the three are not found in this species, and scarcely in *A. Geyeri*.

COLORADO: Glenwood Springs, Aug. 18, 1906, *G. E. Osterhout 3397* (type, in herb. N. Y. Bot. Gard.).

ASTER WOOTONII Greene, Leaflets **1**: 146. 1905.

Aster hesperius Wootonii Greene, Bull. Torrey Club **25**: 119. 1898.

In raising the variety to specific rank, Dr. Greene stated: "Mr. Baker's n. 817 from near Gunnison represents well that of Mr. Wooton's distribution from New Mexico, and I judge the form worthy of specific rank." In the herbarium of the New York Botanical Garden there are duplicates of both *Baker 817* and *Wooton 329*, the latter the type of *A. hesperius Wootonii*. The two are not the same. The latter has the subequal loose bracts and entire leaves of *A. hesperius*, and is best referred to that species; in fact it matches very closely *Wright 1158*, which number I take to be the type of *A. hesperius*. In the former the bracts are well

imbricated in 3 or 4 unequal series and the leaves are distinctly dentate and it agrees in every respect with specimens of *A. paniculatus*. In the writer's judgment it is nothing but the not uncommon pinkish- or light lilac-flowered form of that species.

Aster roseolus sp. nov.

Perennial, with a horizontal rootstock; stem 3–5 dm. high, often purple-tinged, glabrous, pilose in lines on the branches; leaves linear, glabrous or nearly so, scabrous-ciliolate on the margins, 5–10 cm. long, 5–12 mm. wide, inflorescence paniculate but the heads usually few; involucres about 5 mm. high, 8–9 mm. broad; bracts glabrous, oblong or oblong-linear, acute, in about 3 series, often wholly green, with broadly lanceolate tips; rays rose-colored, 5–6 mm. long; achenes hispidulous-strigose.

This species is related to *Aster longulus* and *A. Tradescanti*, but differs in the bright rose-colored rays, the less numerous heads, simpler plant, and broader leaves. It grows in meadows at an altitude of 1500–2000 m.

MONTANA: Melrose, 1895, *Rydberg 2817* (type, in herb. N. Y. Bot. Gard.); Lima, Aug. 5, 1895, *Rydberg;* Logan, July 28, 1895, *Shear 5253;* Emigrant Gulch, Aug. 23, 1897, *Rydberg & Bessey 5121.*

Aster Franklinianus Rydb. nom. nov.

Aster salicifolius Richardson, in Frankl. Journ. 748. 1823. Not *Aster salicifolius* Lam. 1783.

Aster laxiflorus Lindl. in Hook. Fl. Bor.-Am. **2**: 10, mainly. 1834. Not *Aster laxiflorus* Nees. 1833.

Aster laxiflorus borealis T. & G. Fl. N. Am. **2**: 138, in part. 1841.

Dr. Gray referred this to *Aster junceus* but it is more closely related to *A. longifolius*, having the subequal bracts and the dark green leaves of that species, but the bracts are narrower and strictly appressed and the leaves are very narrowly linear and as far as I know perfectly entire. It is *A. laxiflorus* of Lindley mainly but he included a specimen of Mrs. Percival's from eastern Canada (apparently of *A. junceus*), and this very specimen is the type of *A. laxiflorus borealis* T. & G. Otherwise the species would have become *A. borealis* Prov., as Provancher raised the variety to specific rank. He also characterized the eastern plant. The following specimens belong to *A. Franklinianus:*

MACKENZIE TERR.: Slave Lake, *Richardson;* Wooded Country, *Richardson;* Mackenzie River 1861–2, *Kennicott;* Fort Resolution, 1861–2, *Onion, Kennicott & Hardisty.*

SASKATCHEWAN: 1857–8, *E. Bourgeau.*

MONTANA: Gateway, Aug. 17, 1908, *Butler 477, 473,* and *434;* Helena, Aug. 16, 1892, *Kelsey.*

Aster junciformis sp. nov.

Aster junceus Coulter, Man. 161, in part. 1885.

Aster longulus Rydb. Fl. Colo. 356. 1906. Not *Aster longulus* Sheldon. 1894.

Perennial, with a slender horizontal rootstock; stem slender, 3–5 dm. high, simple below, with pilose lines or wholly glabrous below; leaves narrowly linear, 4–8 cm. long, 2–4 mm. wide, scabrous-ciliolate on the margins, light green; inflorescence corymbiform, with the rather few heads terminating the stem and leafy branches; involucres about 6 mm. high, about 1 cm. broad; bracts glabrous, erose-ciliolate; the inner bracts linear, acute, with green midrib and green lanceolate tips, the outer oblong or somewhat oblanceolate, obtuse, and often almost wholly green; rays white, 6–8 mm. long; achenes sparingly hairy or nearly glabrous.

This has been known under the name of *A. junceus* in nearly all western botany, but differs in the always white rays, the subcorymbose inflorescence, and the broader bracts. In the eastern *A. junceus* the bracts are narrowly linear or linear-subulate and the rays are always described as light purple.

MONTANA: East Gallatin Swamps, July 24, 1896, *Flodman 833* (type, in herb. N. Y. Bot. Gard.).

NORTH DAKOTA: Butte, Aug. 5, 1906, *Lunell.*

SOUTH DAKOTA: Custer, Aug. 15, 1892, *Rydberg 775.*

COLORADO: West Cliff, 1896, *Shear 3463, 3817;* Twin Lakes, *Clements 388* and *379.*

MINNESOTA: Minneapolis, 1891, *G. B. Aiton;* Hennepin County, 1890, *Sandberg.*

SASKATCHEWAN: Cypress Hills, 1880, *J. Macoun;* Lake Manitou, July 23, 1906, *Macoun & Herriot 77052;* also Bear Hills, July 29, *77051.*

ALBERTA: Five miles west of Battle River, 1906, *Macoun & Herriot 77053;* also Grattan Creek, Aug. 16, *77050.*

BRITISH COLUMBIA: Swamps at Gold Stream, Aug. 3, 1905, *Shaw 1081*.

Aster eriocaulis sp. nov.

Perennial, with a rootstock; stems about 8 dm. high, leafy, more or less villous, especially above, purplish; stem-leaves lanceolate, 3–7 cm. long, ciliolate on the margins, otherwise glabrous, more or less auriculate-clasping; inflorescence a round-topped panicle; involucres 8 mm. high, 10–12 mm. broad; bracts linear, acute, more or less ciliate, in 2–3 series, with green midrib and lanceolate green tips, or the outermost almost wholly green; rays purple, 8–10 mm. long; achenes sparingly hirsute-strigose.

This species is perhaps most nearly related to *Aster lonchophyllus* but differs in the longer villous pubescence of the stem, the more or less clasping leaves, less imbricated and not purple-tinged bracts. In general habit and leaf-form it resembles somewhat *A. Jessicae*, but differs in the glabrous leaves and narrower glabrous bracts.

IDAHO: Mountain meadows, valley of Traille River, Kootenai County, Aug. 9, 1892, *Sandberg, MacDougal, & Heller 877* (type, in herb. N. Y. Bot. Gard.).

Aster subcaudatus sp. nov.

Perennial, with a creeping rootstock; stem 3–6 dm. high, more or less purple, glabrous below, with villous or pilose peduncles and lines above; lower leaves petioled, 1–2 dm. long; blades lanceolate, 4–10 cm. long, often sparingly dentate with ascending sharp teeth, dark green, glabrous, ciliolate on the margins; upper leaves sessile, linear-lanceolate, attenuate; panicle open, with rather few heads; involucres 7–8 mm. high, about 12 mm. broad; bracts linear-subulate, in 2 or 3 series, but nearly of the same length, attenuate, the inner almost caudate, only slightly white-margined below; rays purple, about 1 cm. long; achenes nearly glabrous.

The type was determined as *Aster Fremontii* (?), but is evidently distinct; differing from that species as well as its relatives, *A. occidentalis*, *A. ciliomarginatus*, etc., in the narrow attenuate bracts. It is also a taller plant with a tendency to having dentate leaves. If one should use Piper's key in his Flora of Washington it would fall under *A. occidentalis* Nutt. The latter, as described in Gray's Synoptical Flora, has well-imbricated bracts, of which the outer are shorter; but neither the present species nor Gray's

description agrees with the original diagnosis of *Aster occidentalis*. It may be that the plant described by Gray should receive a new name. I have not seen Nuttall's type and shall await the chance of seeing it before making such a change.

ALBERTA: Laggan, Lake Louise region, alt. 1950 m., Aug. 23, 1902, *Rosendahl 1089* (type, in herb. N. Y. Bot. Gard.); also *1061*.

IDAHO: Priest Lake, Aug. 1901, *Piper 4120, 3723, 3682*.

MONTANA: Rost Lake, July 15–16, 1901, *MacDougal 661*; Big Fork, July 24, 1908, *Butler 697*.

Aster Umbachii sp. nov.

Perennial, with a slender rootstock; stem slender, erect, simple, glabrous below, sparingly pilose above, 3–5 dm. high; lower leaves about 1 dm. long, petioled; blades broadly oblanceolate or lanceolate, dark green, more or less crenate, acute, glabrous, ciliolate on the margins; middle stem-leaves similar but the petioles with dilated, clasping bases; upper stem-leaves lanceolate, sessile; heads 1–3 in a corymbiform inflorescence; involucres 8–9 mm. high, 12–15 mm. broad; bracts in about 2 series, oblong-oblanceolate, acute, not very unlike in length, glabrous, slightly ciliate, with broad lanceolate green tips; rays dark bluish-purple, fully 1 cm. long; achenes almost glabrous; pappus tawny.

This species is most nearly related to *Aster ciliomarginatus* Rydb. (*A. glastifolius* Greene); but differs in the dark green and mostly crenate leaves and broader and more conspicuously green-tipped bracts. In *A. ciliomarginatus* the leaves are light green, more or less glaucous and entire.

MONTANA: River bank, Lake McDonald, Aug. 20, 1901, *Umbach 275* (type, in herb. N. Y. Bot. Gard.); also *267*.

Aster Mearnsii sp. nov.

Perennial, with a rootstock; stem 3–10 dm. high, leafy, branched, glabrous below, sparingly pubescent above; leaves linear, 5–10 cm. long, ascending-spreading, sessile, entire, glabrous and smooth beneath, scabrous or glabrate above, scabrous-ciliolate on the margins; inflorescence large, paniculate, leafy; heads numerous, disk about 8 mm. high and barely 1 cm. broad; bracts oblanceolate, acute, some longer than the disk; rays about 8 mm. long, white or pinkish; achenes strigulose.

This species is intermediate between *A. oreganus* Nutt. and *A. proximus* Greene. It has often been mistaken for the former, as it has the same narrow leaves and general habit, but differs in the involucre, which is essentially that of *A. proximus*, consisting of foliaceous oblanceolate outer bracts and shorter merely green-tipped inner ones; but the bracts are less squamose and the leaves much narrower, darker in color, and firmer.

WYOMING: Mammoth Hot Springs, Oct. 11, 1902, *Mearns 4806* (type, in herb. N. Y. Bot. Gard.); same locality and collector, Aug. 2, *2731* (?); Aug. 17, *3390;* Gardiner River, Sept. 11, 1902, *Mearns 3915;* Mt. Leidy, Aug., 1897, *Tweedy 561.*

MONTANA: Bozeman, Aug. 24, 1892, *Kelsey;* near Rost Lake, Aug., 1901, *MacDougal 887a;* Belt River, Oct., 1883, *F. W. Anderson 3803v.*

SASKATCHEWAN: Cypress Hills, Aug. 5, 1880, *J. Macoun 7938.*

ALBERTA: Crows Nest Pass, July 31, 1897, *J. Macoun 23076;* overflow from Middle Spring, Banff, July 16, 1899, *Sanson 2241;* Banff, Sept. 24, 1904, *J. Macoun 65486.*

Aster phyllodes sp. nov.

Aster foliaceus Britt. & Brown, Ill. Fl. 3: 371 (excluding figure). 1898. Not *A. foliaceus* Lindl. 1835.

The plant described in Britton & Brown's Illustrated Flora is not *Aster foliaceus* Lindl. of the Northwest, which is a simple plant, with 1–3 large heads and narrowly linear-lanceolate leaves. The figure in the Illustrated Flora was not drawn from my Kimball County plant as stated there. It probably does not represent an *Aster* at all. Evidently some illustrations have been interchanged. The Nebraska plant is nearer to *A. puniceus* in habit than to *A. foliaceus*, although the pubescence and bracts approach the latter. It is more closely related to *A. proximus* Greene, but differs in the more or less toothed and more distinctly auriculate, darker leaves.

The only specimens seen are the following:

NEBRASKA: Lodge Pole Creek, near Kimball, Kimball County, Aug. 12, 1891, *Rydberg 165* (type).

COLORADO: West of Livermore, Larimer Co., Aug. 26, 1896, *Osterhout 2953.*

Xylorrhiza lanceolata sp. nov.

Shrubby perennial, with white stems; branches more or less villous; leaves lanceolate, 4–6 cm. long, more or less villous, especially when young, reticulately veined, dentate with spinulose-subulate teeth, which are directed forward and then falcately curved outward; peduncles 1–2 dm. long; involucre fully 1 cm. high, 15–20 mm. broad; bracts lance-subulate, villous and slightly glandular, attenuate and spinulose-tipped, the inner about equaling the disk, a few of the outer ones often longer and squarrose; rays purple, about 2 cm. long; achenes hirsute; pappus brownish tawny.

This is related to *Xylorrhiza tortifolia* (T. & G.) Greene, but differs in the broader leaves and their teeth. In *X. tortifolia*, the body of the leaves is linear or narrowly linear-lanceolate, the teeth are shorter and broader and diverge at almost right angles to the midrib; the outer bracts are neither elongated nor spreading.

UTAH: St. George, 1877, *Palmer 208* (type, in herb. Columbia Univ. and N. Y. Bot. Gard.); South Utah, 1875, *J. E. Johnson;* 1874, *C. C. Parry 91* (?).

Unamia alba (Nutt.) Rydb. comb. nov.

Inula (*Chrysopsis*) *alba* Nutt. Gen. **2**: 152. 1818.

Aster albus Eat. Man. Bot. 127. 1829. Not *Aster albus* Willd. 1826.

Doellingeria ptarmicoides Nees, Gen. & Sp. Ast. 183. 1833.

Chrysopsis alba Nutt.; Nees, Gen. & Sp. Ast. 183, as a synonym. 1833.

Diplopappus albus Hook. Fl. Bor.-Am. **2**: 21. 1834.

Heliastrum album DC. Prod. **5**: 264. 1836.

Encephalus albus Nutt. Trans. Am. Phil. Soc. II. **7**: 299. 1840.

Aster ptarmicoides T. & G. Fl. N. Am. **2**: 160. 1841.

Unamia ptarmicoides Greene, Leaflets **1**: 6. 1903.

From the various disposition which has been made of this plant, it is evident that the species has been out of place in all the genera to which it had been referred. I therefore agree with Dr. Greene that it represents the type of a distinct genus. Unfortunately Dr. Greene did not use the first available specific name, which is here accepted. Usually the original publication is given as *Chrysopsis alba* Nutt. Gen. **2**: 152. 1818. In that work

Nuttall, however, did not publish it as *Chrysopsis* but as *Inula*, *Chrysopsis* being only a subgeneric name. The Kew Index cites DC. Prod. (*l. c.*) as the place of publication of the combination *Chrysopsis alba*, but it appeared at least one year earlier in Nees's Genera. In describing the genus *Unamia*, Dr. Greene stated: "And that the bristles of the pappus are visibly dilated at the tip is a character, here for the first time noted." This appears to be not quite the fact, for we find in the sectional description in Torrey & Gray's Flora: "the longer bristles clavellate-thickened at the apex;" and in Gray's Synoptical Flora: "pappus white, of rather rigid bristles, longer ones manifestly clavellate at tip." The expressions used by these authors are even more characteristic than Greene's description, for the pappus-bristles are by no means flattened, as the word "dilated" usually implies.

Unamia lutescens (Lindl.) Rydb. comb. nov.

Diplopappus albus β Hook. Fl. Bor.-Am **2**: 21. 1834.
Diplopappus lutescens Lindl.; DC. Prod. **5**: 278. 1834.
Aster lutescens T. & G. Fl. N. Am. **2**: 160. 1841.
Aster ptarmicoides lutescens A. Gray, Syn. Fl. **1**^{2}: 199. 1888.

The color of the rays, yellow or ochroleucous as it has been described, is probably of little value specifically and may vary; but in the specimens seen the bracts are "very obtuse" as described in Torrey & Gray's Flora, the inner even rounded at the apex and therefore different from those of the typical *U. alba*. The range of this species seems to be more restricted than that of *U. alba*, extending from Illinois and Wisconsin to Saskatchewan.

Doellingeria pubens (Gray) Rydb. sp. nov.

Aster umbellatus pubens A. Gray, Syn. Fl. **1**^{2}: 197. 1884.

This I think specifically distinct from *D. umbellata* (Mill.) Nees.

Machaeranthera angustifolia nom. nov.

Machaeranthera linearis Rydb. Mem. N. Y. Bot. Gard. **1**: 398. 1900. Not *M. linearis* Greene. 1897.

Machaeranthera leptophylla sp. nov.

Biennial, cespitose at the base; stems slender, simple up to the inflorescence, green, sparingly puberulent, 3–5 dm. high;

lower leaves petioled, 2–5 cm. long, finely cinereous-puberulent, in age sparingly so; blades spatulate or oblanceolate, entire or sparingly dentate, thin; upper leaves linear-oblanceolate or linear, entire; branches strongly ascending; involucre turbinate, 8 mm. high, 8–10 mm. broad; bracts in 6 or 7 series, linear, acute; green tip short, glandular-puberulent, much shorter than the chartaceous portion, only slightly squarrose; rays rose-purple, about 8 mm. long; achenes finely strigose.

This agrees fairly well with the description of *M. laetevirens* Greene, except that the plant is evidently cinereous-puberulent.

UTAH: Logan, Aug. 9, 1895, *Rydberg* (type, in herb. N. Y. Bot. Gard.).

NEW YORK BOTANICAL GARDEN.

Studies on the flora of Southern California — III

LE ROY ABRAMS

Lepidium bernardinum sp. nov.

Root stout, perpendicular; stem simple below, branched above, or in small specimens simple, 4–6 dm. high, pubescent below with short, deflexed hairs, puberulent above; basal leaves oblanceolate, the blade toothed, 3–5 cm. long, tapering to a slightly longer, somewhat winged petiole, pubescent; petiole ciliate on the margin; stem-leaves narrowly oblanceolate, sessile, pubescent, toothed, those of the ultimate branches becoming entire and nearly linear; sepals slightly exceeding 1 mm. in length; petals oblanceolate, scarcely equaling the sepals; silicels glabrous, 3.5 mm. broad, orbicular or slightly longer than broad, on slender, puberulent, widely spreading, terete pedicels, which are about 5 mm. long; cotyledons incumbent.

A near relative of *Lepidium medium*, but readily distinguished by its pubescence, broader leaves, and larger silicels.

Lepidium bernardinum is common in the coniferous forests of the southern California mountains. The type, which is deposited in the herbarium of the New York Botanical Garden, was collected by the writer (*2826*) in Bear Valley, San Bernardino Mountains, July, 1902.

Cercocarpus minutiflorus sp. nov.

Shrub 2–2.5 meters high, with herbage glabrous throughout; leaves obovate, cuneate at base, serrate-toothed on the rounded summit, 1–2 cm. long, green and shiny beneath, thin; veins 3 or 4 pairs; petioles 4 mm. long; pedicels slender, 7 mm. long; calyx-tube 12 mm. long (in young fruit), 1 mm. broad; calyx-limb 2 mm. broad, minutely and very sparsely tomentulose, its lobes subulate-triangular.

The small bright green leaves distinguish this species at once in the field. The minute calyx-limb with its almost subulate lobes are, also, quite unlike the silky-tomentose calyx-limb and broadly triangular lobes of *C. betulaefolius*.

This species belongs to the chaparral belt of southwestern San Diego County, where it seems wholly to replace *C. betulaefolius*.

FIGURE 1. Photograph of the type specimen of *Amelanchier recurvata* Abrams, about two fifths of its natural size.

The type was collected by the writer (*3376*) in dry chaparral-covered hills, near San Dieguito (Bernardo), May 4, 1903.

The type sheet of this species, as well as those of the following new species, is deposited in the herbarium of the Leland Stanford Jr. University.

Amelanchier recurvata sp. nov.

Low spreading shrub, 1–1.5 meters high; branches slender, spreading and more or less drooping, their bark reddish brown; leaves mostly broadly oblong, 15–25 mm. long, distinctly serrate on the rounded or truncate summit, sparsely tomentulose on both surfaces; veins in 7 or 8 pairs, prominent; petioles slender, 4–6 mm. long; racemes 4–7-flowered; pedicels nearly or quite glabrous, reddish; calyx glabrous without at flowering time, its lobes sharply acute, 3 mm. long, strongly recurved, villous within; petals oblanceolate, 10 mm. long, rounded at the apex, 3.5–4 mm. broad. [FIGURE 1.]

Amelanchier recurvata has the foliage aspect of *A. venulosa*, but is distinguished by its slender, spreading habit, its more glabrous foliage and inflorescence, and by its larger flowers.

Topatopa Mountains, altitude 5500 feet, Ventura County, *Abrams & McGregor 107*, June 4, 1908.

Lupinus Hallii sp. nov.

Shrubby, 6–10 dm. high; herbage canescent with a short appressed silky pubescence; leaflets 7–9, spatulate, 12–24 mm. long; petioles slender, 2.5–4.5 cm. long; peduncles 20–25 mm. long; flowers mostly in whorls 2–3 cm. distant; bracts ovate-lanceolate, acuminate, caducous, 7 mm. long; calyx-lobes 1 cm. long, the upper 2-lobed (lobe 2 mm. long), the lower 3-toothed; standard 15 mm. long, nearly orbicular; wings 15 mm. long, 8 mm. broad, completely enclosing the keel; keel strongly falcate, 5 mm. broad at the angle, conspicuously ciliate on the central part of the inner margins; pod about 4 cm. long, silky-pubescent, 5- or 6-seeded. [FIGURE 2.]

Distinguished from *L. albifrons*, which seems to be confined to central California, by the size of the flower and the structure of the calyx. *L. albifrons* has petals scarcely 10 mm. long, the lower calyx-lobe entire, and the upper lobed to near the middle. The large size of the flower in *L. Hallii* is like that of *L. longifolius*, but the latter has much larger leaves, which are less silky-pubescent, and calyx-lobes of the *L. albifrons* type.

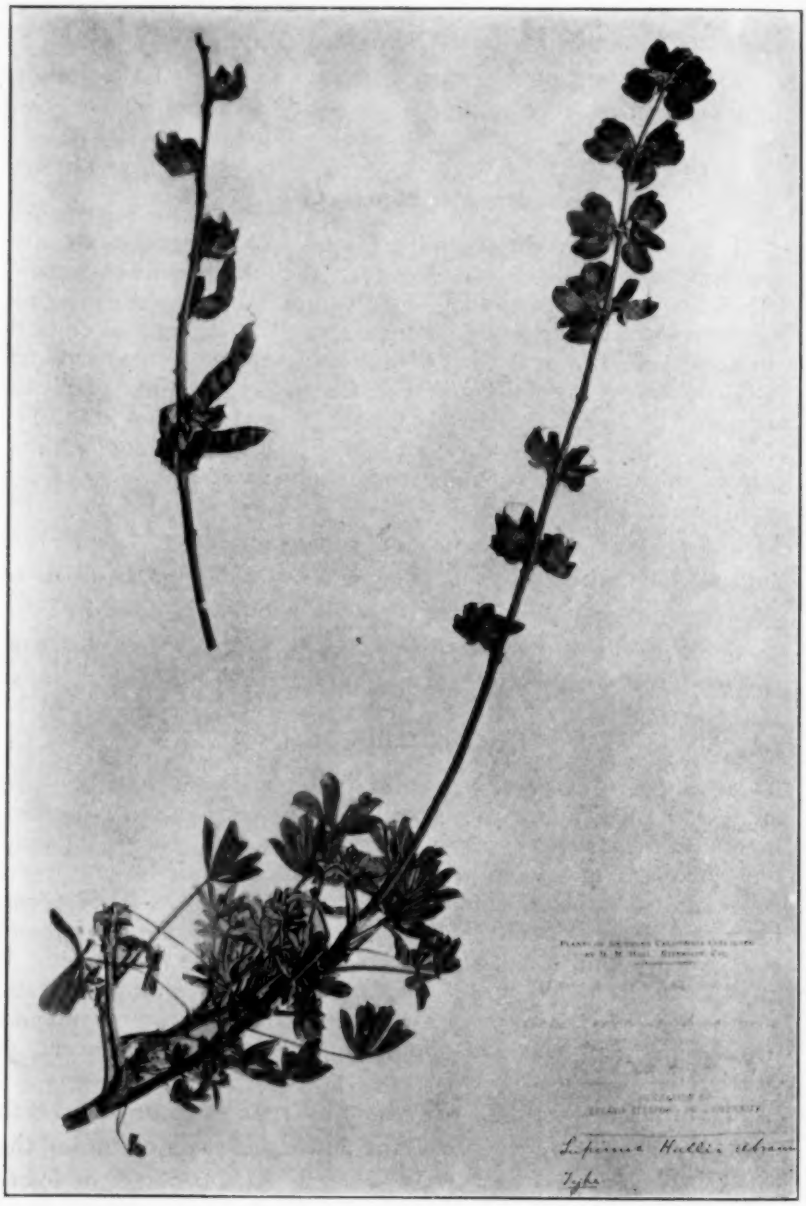

FIGURE 2. Photograph of the type specimen of *Lupinus Hallii* Abrams, about two fifths of its natural size.

Type collected in Reche Cañon, altitude 400 meters, San Bernardino County, *H. M. Hall*, May 15, 1901. *Parish 4772*, collected in the vicinity of San Bernardino, May, 1901, also belongs here.

Rhamnus pilosa (Trelease) Abrams, comb. nov.

Rhamnus crocea, var. *pilosa* Trelease; Curran, Proc. Cal. Acad. II. 1: 251. 1888.

A small arborescent shrub with grayish bark and pilose herbage; leaves broadly ovate or nearly orbicular, 15–30 mm. long, spinose-serrate; calyx of staminate flowers 3.6 mm. long, its lobes ovate-lanceolate, 1.7 mm. long; anthers 0.5 mm. long, nearly as broad; filaments scarcely dilated at base, nearly twice the length of the anthers; fruiting pedicels equaling the glabrous capsules.

This species, which was originally collected in the "Santa Maria Valley, in the mountains back of San Diego," is apparently confined to the San Diego district. It is nearest related to *Rhamnus ilicifolia*, but differs in the pilose herbage, the shorter and broader calyx-lobes, and the minute anthers, which are scarcely half the size.

STANFORD UNIVERSITY, CALIFORNIA.

INDEX TO AMERICAN BOTANICAL LITERATURE

(1903–1908)

The aim of this Index is to include all current botanical literature written by Americans, published in America, or based upon American material; the word America being used in its broadest sense.

Reviews, and papers which relate exclusively to forestry, agriculture, horticulture, manufactured products of vegetable origin, or laboratory methods are not included, and no attempt is made to index the literature of bacteriology. An occasional exception is made in favor of some paper appearing in an American periodical which is devoted wholly to botany. Reprints are not mentioned unless they differ from the original in some important particular. If users of the Index will call the attention of the editor to errors or omissions, their kindness will be appreciated.

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